BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

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New Series. Vol. VII.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1900.

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New Series | January, 1900. | Vol. VI Part I

NOTES ON DYE PLANTS.

The following letter has been received from Dr. E. Bucher of the W. I. Chemical Works :—

"It is very kind of you to offer to let us have some more Persian Berries seeds which I shall thankfully accept. The last seeds supplied, a few years ago, would not grow. They had undergone a putrid fermentation and were quite spoilt. I believe that those seeds were already prepared for the market as a dye stuff, and could not be expected to grow. I hope that your present supply is in a better condition. Persian Berries are still pretty firm and are worth some twenty pounds sterling per ton f. o. b. Smyrna.

"You will remember that you supplied us at one time with East India Indigo, Indigofera tinctoria. The Indigo grew very well, and gave healthier plants than even the native Indigofera Anil. This is unfortunately of no interest in view of the recent synthesis of Indigo. Natural Indigo, which is very cheap already, will become cheaper and cheaper, until it dies a natural death.

"You will be glad to hear that all the India rubber plants sent to us, both the Manihot Glaziovii and the Castilloa are doing splendidly. The Manihot is just now bearing its first pods. I shall carry on cultivation on a large scale with that species. The Manihot seems to do well in the poorest soil. I shall report to you from time to time as to the progress of this cultivation.

The Tinta Maria variety of Honduras Logwood imported by us is growing very well, and I expect to gather a good quantity of seed next Spring. If you wish I shall let you have some. The Tinta Nera variety, also from Honduras, is doing equally well. We have also growing the less valuable Amarilla Catzim from Honduras. This latter variety is coming up in a stunted condition, which is natural to that

variety. It is not worth while cultivating the Catzim. Each variety seems to keep its peculiarities. The Tinta Nera and the Tinta Maria are both very valuable."

PERSIAN BERRIES.

This dye-stuff is the dried unripe fruit of various species of Rhamnus, growing wild, or cultivated in Persia, the Levant, and various countries of southern Europe.

The Persian Berry proper, obtained from Rhamnus amygdalinus, R. oleoides, and R. saxatilis, &c., is imported from Smyrna and Aleppo. Its size is about that of a pea, colour yellowish-green, surface much shrivelled, hard, and divisible along well-marked depressions forming a cross, into four parts, each containing a triangular seed ; its taste is intensely bitter.

Avignon or French-berries, the product of R. infectorius and R. alaternus, etc., are smaller in size than the foregoing, and contain only two seeds.

Spanish, Italian, and Hungarian-berries are respectively the products of R. saxatilis, R. infectorius, and R. cathartica. They are similar in appearance and quality to the Avignon-berries. Other qualities come from the Morea, Wallachia and Bessarabia.

The true Persian-berries are the most highly esteemed, being richest in colouring matter, which resides chiefly in the outer portion, The best qualities are such as have been gathered in an unripe condition, and have a yellowish-green colour ; if too yellow, however, they are inferior, having been gathered in a riper condition ; while if brown or black they are poor and worthless, being either over-ripe or injured or damp during long storage. (Thorpe Dict. of Applied Chemistry) Seeds have been obtained through the kind offices of the British Consul at Smyrna.

CENTRAL AMERICAN RUBBER. *

(*Castilloa elastica*, Cerv.)

Some account of *Castilloa* rubber, and of the species producing it, was given in the *Kew Bulletin* for 1887, pp. 13-16. ** Since then its cultivation as a source of rubber-supply has attracted some attention in Mexico and the West Indies. It has not, however, been easy to obtain any trustworthy data as to the practical methods to pursue or as to the cost and return to be expected. The following account is therefore reprinted from the United States Consular Reports (May, 1899, pp. 147-151). It appears to have been drawn up by a man conversant with the subject and with a good deal of care :—

" Consul-General Beaupré sends from Guatemala, under date of

* Kew Bulletin, 1899, page 159.
** See Jamaica Bulletin, 1895, page 34 ; 1899, pp. 73, 85,

January 28, 1899, a translation of an article on rubber prepared by Mr. Josè Horta, of the city of Guatemala. Mr. Horta, adds the Consul-General, is an experienced agriculturist, and has handled the subject ably. Extracts from his report are given below.

"In Guatemala *Castilloa elastica*, Cerv., is found in the wild state and covers an immense zone in Central America ; the rubber which this tree produces is one of the best and most valuable for the industry.

"The *Castilloa elastica* is a tall, well-shaped tree, with smooth, greenish-white bark. At a height of from 15 to 20 yards from the ground there start from the trunk (of spongy and porous wood) large and almost horizontal branches, from which hang two rows of leaves, long, oval in shape, and smooth edged (not toothed).

"The milk of the rubber tree, or its mercantile product, is contained principally in the fibres between the woody portion of the tree, and the bark. This fibrous part is a vital portion of the tree. For this reason, in making incisions in the bark to obtain the milk, it is necessary to proceed with great caution and according to the method described further on.

"The milk contains more or less water, according to the time of its extraction ; on an average it can be calculated to hold about 60 per cent. water and other substances, and 40 per cent. saleable product ; of this, approximately 33 per cent. is rubber of superior quality.

"The climate most appropriate for rubber is the hot or coastal, with a temperature of from 25 ° to 35 ° Celsius (93 ° to 103 ° F.) and the altitude above sea level up to 1,500 feet. The ground should be moist, deep, and loose ; neither clay nor stone. Rubber should not be planted in the sun. We found our opinion upon the following reasons :—

"(1.) The nature of the rubber tree.

"(2.) The trials made in Guatemala since 1872.

"(3.) The consideration that, planting in the shade, there is absolute certainty of a satisfactory result.

"If the wild tree always seeks the shade of trees of greater growth in the natural forests, it is because, by the help of these, its sap remains in the state imposed by nature as a condition of its proper growth and production. It is not the desire here to make a detailed study of the tree ; but we wish to note that its leaves do not resist the sun, nor do they, by the nature of their surface, oppose evaporation. It is clear that without shade there is an evaporation which must exercise a harmful influence upon the production of the milk of the tree. It should also not be lost sight of that on the Pacific Coast we have a dry season for six consecutive months, very prejudicial to plantations in the sun. Allow the rubber tree a high and well-distributed shade, without undergrowth or brush, and the result will be healthy and robust trees of rapid growth, long life, and abundant yield. It is a mistake to wish to cultivate plants, such as coffee and rubber, requiring distinct climatical conditions, soil, and atmospheres, with the desire of obtaining good yields in both. The result is that neither one nor the other finds the requirements necessary for proper development. It would appear

much more feasible to conduct the cultivation of vanilla simultaneously with that of rubber, utilizing the trees for shade.

"Advocating the planting in the shade is equivalent, in a country like Guatemala, still possessing so much virgin forest, to planting in the woods. There are thousands of acres of land where it would be sufficient to clear the forest (cutting down part and removing the low branches and undergrowth) in order to obtain ground sufficiently shaded and with the necessary ventilation, the latter a condition of the greatest importance. The trees and undergrowth cut down could be spread over the ground to prevent the growth of weeds, as well as to serve as manure. In planting the rubber tree the ground should be perfectly cleaned for a circle at least a yard in diameter and the tree placed in the centre. We advise the planting of trees taken from a nursery, as incomparably better results will be obtained than by planting by seed. The nursery is formed in damp ground, shaded and well worked, and the seed (which is gathered here in March and April) planted at intervals of about a foot. The seed is planted just as gathered, with gum and all; washing may injure the later growth and may even prevent sprouting. After a year in the nursery the trees are taken out with great care (it is best if the earth adheres to the roots) and transplanted.

"The least distance at which rubber trees should be set out is 6 yards apart, and they should be in straight rows so far as possible; if a choice can be made, 8 to 10 yards would be preferable. During each of the first two years, from three to four cleanings should be made, these to consist principally of cutting with the machete the undergrowth which has sprouted, and covering the ground as has previously been explained. In the third and fourth years, two or three cleanings per year should be made; and from the fifth year, one cleaning annually will suffice until the growth of the tree impedes the further development of weeds. Before beginning to exploit, the trunk of the tree should measure at least 12 inches in diameter, and from 12 to 15 yards in height, for which from nine to ten years is necessary.

"The milk may be extracted from the trees twice each year, during the rainy season; about two months after its commencement and towards the termination, the most propitious time being when the tree has dropped its leaves.

"A tree planted and cultivated under good conditions will give an annual product, after nine or ten years, of 1 pound of rubber, or, say 2½ to 3 pounds of milk. With proper study of the nature of the rubber tree, the progress of its sap, and the fertilizers that might be best for it, it is very probable that this yield would be greatly increased.

"Extraction of Rubber.

"Until now, the machete has been used in Guatemala to make the incisions in the bark, incisions in the form of small canals about three-fourths of an inch wide, which receive the milk. In other countries (as in the East Indies) there is employed a kind of knife, which allows the making of an incision which is cleaner and better directed.

"To extract a good quantity of milk it is not sufficient to make only one incision at the foot of the tree. Care should be taken that the

bark of the tree remains intact in one continuous strip the entire height of one side of the tree; if the entire circumference of the trunk were cut (even by incisions situated at different heights), the tree would die within a few days. To avoid this danger we have seen the following modes employed :—

"(1.) From a certain height above the roots, incisions are made in the trunk every metre or metre and a quarter approximately, until within two metres of the first branches. Each incision consists of two symmetrical cuts, which together will cover two-thirds of the circumference of the tree, and will form an angle of 45°, in order that the milk may run freely to the lowest point. The points of all the incisions must be in a perpendicular line, so that the milk from the highest incision, after concentrating in the angle formed by the two cuts, may run to the lowest point of the next lower incision, and from there on to the following, etc., until reaching the lowest, where it is collected, as explained further on.

"(2.) The incision is extended to the same height of the trunk as indicated in the first method, but is continuous, and consists of cuts, one perpendicular to the other, always taking care never to cut into more than two-thirds of the tree's circumference, thus leaving one-third of the bark intact.

"It is useless and even dangerous to make the incisions so deep as to penetrate the woody part of the tree. On the contrary, great caution should be exercised to preserve the fibres closest to the wood.

"From the point of the incision nearest the ground the milk is conducted by a canal to a receptacle of clay or wood. When collected thus, the milk must be coagulated to obtain the solid marketable product. This part of the process merits a serious study, as the best mode of obtaining the finest and most abundant product has not been decided. We limit ourselves to indicating the principal processes we have seen employed.

"The most rudimentary consists in collecting the milk in a trough or even a hole excavated in the ground (which detracts from its value) and employing in its coagulation the juice of the vine, here called 'Quiebra-Cajete' (an infusion of the leaves of the vine.) Alum can also be employed, and exercises a very rapid action on the milk. The water contained in the milk may be evaporated by indirectly applied heat, taking care that the receptacle does not communicate a bad colour to the rubber; or, the milk may be mixed with water, which is poured off at intervals, until all impurities are removed. The clean rubber, which presents the aspect of a spongy mass, is passed through a press to expel the water, thus obtaining a white product of superior quality, which is left to dry in the shade, in order that it may not show on the outside a glutinous liquid, which detracts from its market value.

"Cost and Probable Production of a Plantation.

"This calculation must naturally be incomplete, as the cost will depend in great part on the price of the lands, on the greater or less

facilities for obtaining workmen, the mode of paying them (by day, by task, with advances, etc.), on the distant apart that trees are to be planted, whether the land is to be used exclusively for rubber or not, and on many other considerations.

"The figures expressed herewith, therefore, do not pretend to a rigorous exactitude, but will serve as a guide for the agriculturist.

"We will suppose that the trees are to be planted at 8 varas (1 vara = 33 English inches) distance, so that each will have an approximate area (with space occupied by shade trees) of 64 square varas, which we believe necessary for their proper development, thus allowing approximately 10,000 trees to the caballeria (112 acres) ; cost of land at $400 ($175.60 in United States currency) * per caballeria, a price somewhat high, as some coast land (hot) adequate for this cultivation can be purchased in Guatemala for less ; but we have adopted this figure, as, according to existing laws, it is the average cost of public lands in the Republic.

	Guatemalan currency.		United States currency.
	$		$
Cost per manzana†	6.25	...	2.74
Fencing per manzana	10.00	...	4.39
Nursery, at $10 per 1,000, say, for 159 plants	1.59	...	.69
Preparation of ground and arranging natural shade, per manzana ...	8.00	...	3.51
Planting 159 trees to the manzana ...	3.00	...	1.32
Cleaning by machete, four in first year	16.00	...	7.02
Three cleanings in second year ...	12.00	...	5.27
Two cleanings in third year ...	8.00	...	3.51
One cleaning each year from fourth to sixth, inclusive	12.00	...	5.27
Interest on invested capital, at 10 per cent. for ten years	68.78	...	30.19
Management, etc.	4.38	...	1.92
Total cost in Guatemala (200 per cent. premium is ruling rate on gold to-day) of 159 trees occupying a manzana of ground, and 10 years old ...	150.00	...	66.00

"From the foregoing calculation it may be seen that a plantation of, say, 100,000 trees requires 10 caballerias of ground (besides that which may be necessary for building, huts, etc.), and would cost, after ten years, about $95,000 ($41,700).

* The value of the Central American peso, or dollar, was estimated by the United States Director of the Mint, January 1st, 1899, at 43.9 cents.

† Square of 100 varas, or 275 feet.

"If the annual yield of each tree after ten years is 1 pound of rubber of good class, 100,000 trees would give 1,000 centals per year of good rubber. At present price of the article, these 1,000 would be valued in Guatemalan money at to-day's exchange $260,500 ($115,238) There is to be deducted from this :—

	Guatemalan currency.		United States currency.
	$		$
Cost of extraction and collection of the milk and manufacture of product (which together may be calculated at 30 cents. per pound of rubber) for 1,000 centals	30,000	...	13,170
Expense of transportation to point of shipment (which varies in each case, but can be calculated in lands situated on the Pacific coast at $1.50 to $2 per cental) for 1,000 centals...	1,750	...	768
Expense for embarking, more or less, 80 cents per cental, or, for 1,000 centals	809	...	355
Ocean freight, insurance, commission on sales, and other expenses, approximately...	40,000	...	17,560
Total	72,559	...	31,853

"Deducting the cost of $72,559 ($31,853) from the income, leaves a balance of $189,941 ($83,385.)

"According to these calculations, one crop, after ten years, will produce double the amount expended during that time. Even reducing these figures (which are not too high) to one-half, in order to be free from any exaggeration, and supposing a yield per tree of 6 ounces of good product, the net annual product will be incomparably more remunerative than that which coffee under the best and most favourable circumstances can yield."

FERTILISERS FOR PINE-APPLES.

A Florida Pine-Apple grower recommends the following fertilisers:—

Bright Cotton Seed Meal, at the rate of 1 ton per acre per year, applied once a month.

Ground Bone, to be applied before planting at rate of 2 tons per acre. This need not be renewed perhaps for 20 years.

Tobacco stems, unsoaked and uncut, at the rate of 1 ton per acre per year, applied twice a year. This is supplied by the trade in bales.

VANILLA, AND OTHER CULTURES IN RÉUNION.

REPORT FOR THE YEARS 1895-96 ON THE TRADE AND AGRICULTURE OF REUNION.

Consul Bennett to the Marquis of Salisbury.
(Received at Foreign Office, June 25, 1897.)

My Lord,

I have the honour to enclose a Report upon the Trade and Agriculture of Réunion for 1895 and 1896 with special reference to the successful efforts which have been made in Réunion to supplement the cultivation of the sugar cane, by other cultures suited to tropical climates.

As many requests have been addressed to this Consulate regarding the treatment of vanilla by chloride of calcium, I also have the honour to forward a translation of a note explanatory of the working of the whole system of preparing the vanilla bean, which has been courteously drawn up for me by Monsieur G. Mirel of the Crédit Foncier Colonial at the suggestion of the manager.

I have, etc,

C. W. BENNETT.

Few tropical lands, perhaps, can compare with Réunion in the advantages offered to agriculture by varied climates, valley, plain, and mountain. In my report for 1892 a general description of the island was given to which it is for present purposes only necessary to add a few words to show that, if anywhere, here in Réunion "la petite culture" ought to succeed and pay well, not as a substitute for the sugar industry, but in connection with it. Monsieur Maillard, in his "Notes sur l' Ile de la Réunion," published at Paris in 1862, writes as regards the rage for cane planting which was then even more universal than to-day: "We are convinced that sooner or later the cultivation of cane will disappear; we can even now point to localities, as, for instance, the lands situated between St. Denis and Possession which were formerly laid out in coffee plantations, and that have now been destroyed to plant cane, and where this cultivation has already become impossible owing to the denudation by water of the soil."

In this prophecy, pregnant with truth, lies the cause of one of the chief agricultural difficulties of to-day. The thoughtless grubbing-up of coffee and clove plantations, and the ruthless cutting down of the beautiful forests, full of valuable timber, much of which was cleared by fire, has changed the face of the country. The forests, which formerly acted as sponges sending out fruitful water and humus over the lower lands, are now more or less clear. After rain the water rushes from them in a freshet, carrying all before it, and sweeping the denuded sides of the mountains, gradually reduces them to bare rock or crumbling shale, and washes instead of fertilising the plateaux.

Looking at a map of Réunion, a stranger is immediately struck by the number of rivers indicated, and naturally concludes it to be a well-watered land. But as a fact nine-tenths of the rivers and streams marked are merely dry watercourses which run only for a few hours after heavy rains. A closer examination of the lower deposits shows that many of these mountain torrents were formerly slow-moving rivers. Had not Government stepped in with a very strict forest law, and liberally restocked the forests where necessary, the Island of Réunion would in course of a hundred years or so have been as barren as the rocks of Aden, or the denuded deserts of Abyssinia. It takes, however, only a few minutes to cut a tree down, but many years to bring a new one to perfection, and the mischief done will take very long to repair. Thus, in the meanwhile, considerable tracts of land have gone out of cultivation, and must perforce lie fallow for long periods. The mischief is arrested, but far from completely stopped. The forest laws apply in only a very limited way to private lands, and with rare exceptions very few private landowners do much replanting, except for fuel purposes, whilst the smaller owners, who live from hand to mouth, seek only how to make the most ready-money possible out of their forests, and think not of the future or the result to their own and their neighbours' lands. As a matter of fact, forest clearing, and especially on steep slopes, is even now carried on in far too reckless a manner.

There still remains, however, plenty of land fit for cultivation besides the sugar belt running round the island, and up to about 1,500 feet on the slopes.

The upland plains of Salazie, Pilaos, Plaine des Cafres, Plaine des Chicots, and Dos d'Ane, amongst others situated at from 3,000 to 5,000 feet are all cultivable, and, except the Plaine des Chicots, more or less cultivated, but from 5,000 feet upwards the soil is practically non-existent, and cultivation is impossible.

The Réunion sugar culture has been fully explained in my report above referred to, and calls for no further remarks, except to observe that the fall in the price of sugar and the beet competition have been felt almost as accutely in Réunion, in spite of protection, as in the British West India colonies. A distinction, however, must be drawn between planters and millowners. In spite of hard times millowners have been able to offer to planters prices for canes brought to the mill to be crushed which have given fair profit to the planter. The better the mill, the better the sugar product, and, therefore, if the planter elects to be paid in sugar, the bigger profit for the planter who chooses the best mill available. It is the millowner who has chiefly felt the pinch. Centralisation of mills has long been recommended, and under given circumstances works well. Decentralisation, i.e., division of labour, would, perhaps, work better, the millowner sticking to his trade as miller, and the planter to his as planter, mutual contracts existing between millowner and planter as to lands to be cultivated and the labour to be supplied on more or less the lines of the Queensland Sugar Acts.

But Réunion would be in a far worse plight to-day than she actually is if she had depended entirely upon sugar. It is hardly too much to say that her planters, or many of them, have been saved from

ruin by having a second string to their bow. Many a deficit on sugar has been covered by a handsome profit on vanilla, backed up by sales of manioc (cassava) coffee, tobacco, perfumes, cloves and market garden produce.

The largest of all these secondary products is undoubtedly vanilla.* There is hardly a sugar estate in the island which has not more or less land under vanilla, varying naturally in extent according to the nature of the locality. On the other hand, in certain districts are to be found large planters who cultivate nothing but vanilla, and as regards the quarters of Ste. Rose, St. Philippe, and St. Joseph, it is no exaggeration to say that the mainstay of the people is vanilla. The yards and courts and little plots of ground round the huts are covered with the vanilla creepers. When the pods are ripe they are sold green to a neighbouring merchant, realising quite a small fortune for the grower. The only drawback to this crop is that it gives rise to an immense amount of theft and dishonesty. The pods are stolen by night, and in spite of stringent laws are passed from hand to hand, and finally lost for ever to the grower. Many considerable fortunes are known to have been accumulated by illicit vanilla buyers, but the detection of the culprit is almost as difficult as that of a diamond thief at the mines. In a separate report I am drawing further attention to the treatment of vanilla by chloride of calcium.

The next largest industry is that of coffee. The coffee shrub is generally planted in the higher lands, where the cane, if it grows at all, does not do well. The output is increasing yearly, but although many parts of the island are admirably suited to coffee, planters hesitate on account of the length of time before bearing, and fear of the hemeleia vastatrix to change from the quick-producing cane. Slowly but surely, however, coffee is forcing its way and in time it is hoped to equal if not to surpass the output of the palmy days of Réunion of 1824-29. Coffee also enters largely in the Creole diet, and there are probably no sugar planters who buy a pound of coffee in the year, and many private persons grow enough for their daily use.

The tobacco plant is largely grown, but not on any great scale by the sugar planters. As a rule it is found in small plots of newly cleared land, belonging to quite poor people. It is in great demand by the Creoles, both in Réunion and Madagascar, and a fairly large quantity is exported to Mauritius.

Tobacco is a Government monopoly, and no doubt were it freed from the many trammels which surround its cultivation and sale, it would be produced more largely. On the whole it is a crop which pays well, and it is estimated that the annual local consumption in Réunion alone is 1 kilo. per head. The aroma, if not agreeable, is strong, but Réunion tobacco is not much favoured except by the natives.

Another crop which figures largely on Réunion sugar estates is that of manioc (cassava.) It serves a double purpose: first of all as a covering for lands lying fallow, after a sugar crop, and next as food for

* An article on Vanilla was published in the Bulletin for October, 1888, No. 8, which can still be sent on application.

man and beast. It is extensively planted, and has now quite become a native dish. Curiously enough, although the original plants came from Brazil, the Bourbon root is not poisonous, horses and cattle can eat it raw without harm. The wild manioc of Brazil is always poisonous, and generally more so than the cultivated plant. But the "manioc doux" is not poisonous, and can be eaten without any preparation of the poisonous or bitter manioc (manioc amas). There are many varieties, which are more robust and productive than the others, and there is every degree of poison, from very little to much. Cattle, however, have been known to die after eating manioc, but their death is never attributed to the direct effect of poison, but to indigestion, work too soon after feeding, but such cases are very rare.

Large quantities of rum are also made from the sugar residue, but almost the whole profit, so far as the distillers are concerned, is consumed in paying the Government excise dues.

Tentative efforts to produce liqueurs from native fruits; such as the letchi, vanilla, bibasse, etc., have also been made, but as yet the output is on a small scale.

Perfumes of various sorts, geranium, patchouli, vetyver, ylang ylang, are also made; they are good in quality, but difficult to place on the European market in competition with known brands, but they all produce more or less profit, and the process is so simple that many ladies carry on the opperations in their kitchens as an aid to household expenses.

As regards textiles many fibrous plants are to be found in the colony, and no doubt ramie and others would do well here but the difficulties of treating fibres, and of finding a profitable market for the product have almost put an end to these industries.

The only remaining one is practically the making of coarse bags for sugar from the vacoa tree [Pandanus, Screw Pine.] In Mauritius the vacoa bags are used as a first packing for high-class sugar with a gunny bag from India outside. For low sugar vacoa bags only are used. A small business however, is done in making ladies' hats and fancy objects in vetyver [Khus khus grass] and other fibres, but purely as a domestic occupation.

Tea also grows well in Réunion, but there is no local consumption for it, and market prices are now so low that it would appear to be a profitless enterprise to plant it to a large extent. The latter remark applies equally to rice.

In the foregoing remarks the nature of agricultural pursuits in Réunion is fairly summed up. The main industry will be seen to be sugar, coffee, and vanilla and tapioca forming the only serious aids to counteract low prices and losses on sugar. But the fact must not be overlooked that large Indian corn, bean, and pea crops are grown upon all estates, and that market garden produce is largely cropped either for family consumption, for supply to neighbouring towns, or for export to Mauritius and Madagascar. With the exception of flour, beef, and rice, all of which are imported, a well-managed Réunion estate is practically self-supporting as regards men and beasts and fuel for the mill, for no

coal is used in the mill furnaces ; and according to its vicinity to town or railway can make a considerable yearly income by the sale of markes produce, etc.

Continuous efforts are made to substitute Indian corn, peas, beans, lentils and mandioca, for imported rice, and one of the results of the plague at Bombay has been to very largely aid in forcing the inhabitants to look to native products in view of the great rise in the price of rice. As a rule, however, the market gardener is sadly hampered by want or means of communication ; he can grow beautiful produce, but before he can reach the consumer, freight has eaten up the profits ; neither are export duties charged at the ports favourable to the development of a trade with foreign or neighbouring countries.

Something has been done to save the island from depending solely on sugar, but there is room for improvement. Réunion ought to grow all its own corn on its fertile upland plains. Horse and cattle rearing could be profitably extended and sheep-raising on a smaller scale with the bye-products of soap, candles and manures. But in a country where routine is all-powerful and capital somewhat short, it is difficult for people to get out of the ordinary rut unless initiative and funds come from outside. At the same time what has been done is to the credit of Réunion, and her example may well be held up to British tropical colonies as one to be followed.

. . . .

Explanatory Notes as to the Drying of Vanilla by Chloride of Calcium.

The object aimed at in the treatment of vanilla is to endow it with keeping properties, and at the same time to develop the perfume which has not yet come into being at the moment of cropping.

Pods of the best quality should be perfectly smooth, and without excrescences or holes. The longer the pods, and the more perfumed they are, without acidity, the more valuable the vanilla.

The success of the treatment of vanilla depends upon the care bestowed upon it, and especially upon the state of maturity of the pods.

If the vanilla is picked too green, its treatment will be difficult and its keeping qualities doubtful, the pods will be thin and poor after drying, whilst the perfume will not be properly brought out, and what there is will be lacking in quality.

If plucked when too ripe, the treatment will be easy, it will be of good size, and highly perfumed, but it will split, and thus lose much of its commercial value.

On a well ventilated and properly exposed plantation, the pods are ripe when the lower part begins to turn yellowish.

The treatment by chloride of calcium, $CaCl_2$, as indeed do all the other methods of treatment, consists of several operations:—

1. Stoppage of vegetation.
2. First drying and colouring.
3. Drying.
4. Watching.

1. The process of drying in a stove by means of hot water, is the one resorted to. On the day of the cropping, or the next day at latest, the pods are put to dry by heat in thin cases of the following dimensions: —0.220 metres by 0.220 metres by 0.350 metres. Old petroleum oil tins are generally used for the purpose. The size may be slightly altered, but the width and breadth of the box should not be too large, as the vanilla in the centre should be subjected to the same heat as that which is nearest to the sides of the box. Otherwise the treatment of the pods in the centre would not be assimilated to that of those at the sides, and the resultant colouring would be slightly different.

These boxes are fitted with lids closing on the outside of the box. They are lined with wool carefully arranged along the bottom and up the sides, and a little over the top of the sides.

The vanilla pods are placed on end close enough to secure pressure without damage by rubbing; a horizontal layer is placed on top of these, the woolen covering is folded over all and the lid put on.

The boxes thus arranged are put into the halves of wine barrels and hot water emptied into the barrels up to the lid of the boxes care being taken that no water gets into the boxes. In order to prevent the sudden cooling of the hot water, the barrel is covered with a piece of sacking. It is left thus covered during one night.

2. Next morning the pods are withdrawn and exposed in the air for some time to dry ; then for two or three days they are kept under woolen coverings in full sunlight.

For this operation low wooden boxes are used, a single layer of pods being placed in the bottom and covered with a woolen cloth. The boxes are placed in sunlight on trestles to prevent contact with more or less moist earth. After this operation the colouring of all the pods will be uniform if the drying by hot water has been properly done.

Now is the moment to proceed to the drying operation.

3. The old methods of preparation, drying in the open air upon screens in an airy situation, or in hot-air stoves, in which the heat is constantly renewed, result in a loss of perfume and at the same time require a large amount of hand labour. These drawbacks are avoided by drying in closed vessels by means of chloride of calcium, $CaCl_2$.

This operation is carried on in boxes of galvanised iron with a hinged door and closing on an india rubber edging to ensure air-tightness.

Each box has eleven drawers or trays; the bottom and the sixth drawers are for the vessels containing chloride of calcium, the others are for holding the vanilla; in the former are placed 18 kilos. of chloride of calcium and in the latter 45 kilos. of vanilla.

The vanilla is laid upon wooden hurdle-shaped frames resting upon little brackets rivetted into the sides of the box. The tray can thus be drawn out in order to arrange the vanilla properly. Several layers are placed on each tray.

The trays should not be made of resinous or smelling woods, as vanilla absorbs and retain odours it comes in contact with; the hurdling is made of split rattans.

The vessels containing chloride of calcium should be double bottomed, the inner one being perforated to allow of the escape of the liquid cloride of calcium. Each time the case is opened the chloride vessels should be looked to and the chloride renewed or added to as necessary. When the trays are filled with vanilla and the chloride vessels are in their places the door is closed and should fit perfectly into the doorjamb. To be quite sure that the boxes are hermetically closed all rivets in the box should be soldered beforehand.

Every two or three days the vanilla is carefully examined, and pods showing moisture are taken out and put aside to be sunned and prepared by themselves in a special box where they are all collected.

In from 25 to 30 days the vanilla will have reached the required degree of dryness. Practice will show the exact moment when they should be withdrawn.

Vanilla insufficiently dried will not keep and breed small worms; vanilla over-dried keeps well, but it is not supple, it is called "broken" (brisée) and has less commercial value.

4. After leaving the box, the vanilla is placed for several days on small frames in a covered and well-ventilated place, then it is removed and shut up in tin boxes, each holding from 15 to 20 kilos. of vanilla.

There it remains for several weeks, being examined every two or three days and any showing traces of mildew are carefully wiped.

When it is thought that the vanilla has reached perfection (rendue à point) and its perfume well developed, the cleaning of the vanilla is taken in hand in order to remove the dust and the germs of mildew which may adhere to it. Vanilla which is not subjected to this process is dull in colour and does not keep well.

Twenty-five to thirty litres of water at about 60 per cent. (140° Fahr.) are emptied into a perfectly clean receptacle and 15 to 20 kilos. of vanilla are thrown into it and vigorously stirred up in the water by hand.

The pods are withdrawn, lightly wiped and put to dry in the shade. In a few days when the pods are dry, they are sorted and classed according to length and quality, and made up in bundles. All these operations must be conducted with the greatest care. The bundles are placed in tin boxes with covers. Each box contains only vanilla of the same length and quality and holds from 4 to 5 kilos. each.

Vanilla should never be sent away immediately after dealing with it. It must be watched for at least a month to be quite sure that it will keep good during a sea voyage.

During the time it is being watched the boxes should be examined twice a week and every pod showing the least trace of moisture should be withdrawn.

The mildewed pods are worked up by various processes and sold as quite inferior vanilla.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

LIBRARY.

EUROPE.

British Isles.
Botanical Magazine, Dec. [Purchased.]
British Trade Journal, Dec. [Editor.]
Chemist and Druggist, Nov. 18, 25, Dec. 2, 9. [Editor.]
Garden, Nov. 18, 25 Dec. 2, 9. [Purchased.]
Gardener's Chronicle, Nov. 18, 25, Dec., 2. 9. [Purchased.]
Journal of Botany, Dec. [Purchased.]
Journal R. Colonial Institute, Dec.
Journal, R. Horticultural Society, Nov.
Nature, Nov. 16, 23, 30, Dec., 7. [Purchased.]
Pharmaceutical Journal, Nov. 18, 25, Dec. 2. [Editor.]
Produce World, Dec. [Editor.]
Sugar, Nov. [Editor.]
International Sugar Journal, Dec. [Editor.]
W. Indian and Com. Advertiser, Dec [Editor.]
Board of Agriculture Leaflet, Nos. 57, 58. [Sec. Board of Agr.]

France.
Sucrerie, indigene et coloniale, Nov. 14, 21, 28, Dec., 5. [Editor.]

Germany.
Tropenpflanzer, Dec. [Editor.]

Switzerland.
Bulletin de l'Herbier Boissier, Nov. [Conservateur.]

ASIA.

India.
Calcutta, Agri. and Hort. Society of India, Jan., Sept. [Secretary.]
Planting Opinion, Oct., 28, Nov. 4, 11, 18. [Editor.]
Indian Gardening (Calcutta) Nov., 2, 9.

Ceylon.
Times of Ceylon, Nov. 1. 9. 15. 23, [Editor.]

AUSTRALIA.

N. S. Wales.
Agri. Gazette, Nov. [Dept. of Agr.]

Queensland.
Agri. Journal, Nov. [Sec. Agr.].

AFRICA.

Cape of Good Hope.
Agri. Journ. Oct. [Editor.]

Central Africa Times.
Sept. 9, 30., Oct., 7, 14, 21. [Editor.]

Mauritius.
Revue Agricole, (Supplement) Nov.

WEST INDIES.

Jamaica.
Journal, Jamaica Agri. Soc. Dec. [Secretary.]

Trinidad.
Proc. of Agri. Soc. Oct. 10, Nov. 14. [Secretary.]

BRITISH NORTH AMERICA.

Montreal.
Pharmaceutical Journal, Dec. [Editor]

Nova Scotia.
Proc. and Trans. Inst. of Science, Vol. ix. Pt. 4. Session of 1897-98. [Secretary.]

Provincial Govt. Crop Report. Nov. 1899. [Sec. of Agr.]

Ontario.

Report of Farmers' Institutes for 1898-9. [Dept. of Agr.]

Ottawa.

Farm Pests, By Dr. J. Fletcher, Ottawa. [Author.]

UNITED STATES AMERICA

Publications of the U. S. Dept. of Agriculture—Scientific Bureaus and Divisions (Directors.)

Division of Forestry, 26, Practical Forestry in the Adirondacks.

Division of Vegetable Physiology and Pathology, 16, Cereal Rusts; 17, Wilt Disease of Cotton Watermelon and Cowpea.

Experiment Stations. [Director's.]

Experiment Station Record, Vol. XI., No. 3; Circular No. 42.

Maryland, Vol. 12, Report, S. Jose Seale, Sweet Potato Insects and Diseases, Experiments with Corn and Potatoes.

Michigan, 175, Insects; 176, Strawberry.

Nebraska, 55, Ornamental Planting. 56, Tree planting, 58, Forage Plants; 59 Windmills; Report; P. Bn. 11, Calves, P. Bn. C. 1. Grasshoppers; 2 Army Worm.

New Hampshire, 66, Pig Feeding.

New Jersey, 140, Scale Insects.

Texas, 53, Texas Fever.

Virginia, 10, Wheat Fertilisers; 11, Experimental Vineyard.

American Journal of Pharmacy, Dec. [Editor.]

Botanical Gazette, Chicago, Nov. [Editor.]

Field Columbian Museum Publications, Chicago, Vol. 1, No. 4. For, 1897-98.

Smithsonian Inst. Report, 1896. [Secretary.]

Torrey Club Bulletin, Dec. [Editor.]

Missouri Botanical Garden, 1898, Report. [Secretary.]

SEEDS.

From Agr. and Horti. Society of India, Calcutta.

Beaumontia grandiflora.

From Imperial Dept. of Agri. for the West Indies.

Everlasting Cow Pea	Speckled Cow Pea.
Black eye " "	Coffee " "
Black " "	Saddle back "
Red " "	Red Yellow hull Cow Pea.
Flax Red " "	Dolichos Mingo
Conch " "	D. Catiang
Calico " "	D. Formosa
Unknown " "	Cyanopsis from Hindostan.
White " "	Phaseolus helvolus, St. Helena Pea.
New Era " "	

From Lady Blake, Hong Kong.

Nymphaea Lotus.

Nymphaea stellata.

Michelia fuscata.

Strychnos paniculata.

Manglietia Fordii.

From Mr. W. Jekyll, Robertsfield.

Sweet Sop.

From Dr. Plaxton, Kingston.

Lignum Vitae

[Issued 15th January, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series **February, ~~1899.~~ 1900.** **Vol. VII Part II.**

RAMIE.

The following correspondence has been received :—

Commissioner, Imperial Dept. of Agri., Barbados, to Director, Public Gardens and Plantations, Jamaica.

28th December, 1899.

You may already have received a letter from Sir Frederick Abel a copy of which is enclosed.

It may be of interest to you to learn that a promising machine invented by the "International Fibre Syndicate" (28, Victoria Street, Westminster S.W.) is now under trial in Dominica. I saw this machine at work in London and I regard it as a distinct advance on any previous machine. It has a continuous feed (that is there is no reversing necessary) and the fibre is delivered on a long endless band almost free from wood and bark.

Sir F. Abel, Imperial Institute, to Imperial Commissioner of Agriculture for the West Indies.

30th November, 1899.

An offer has been made to me by a firm of Brokers of high standing for Rhea Ribbons (i.e., the bark and fibre as stripped from the stems) in any quantities that can be supplied. The price proposed to be paid for it, is £15 per ton, the cost of freight and insurance being paid to London.

I should be very glad if you could see your way to make this known to any cultivators in the West Indies to whom you think the offer may be of use.

BALLAM RICE.

A correspondent enquired "if the Ballam trade rice as shipped to England, is usually steamed before being cleaned and hulled. The rice I see that comes here as Ballam has a yellowish appearance and a rather peculiar smell and seems best liked in that condition—The coolies here tell me it is rice that has been heated in water over a fire, or by steam I presume by a large grower."

The query was referred to the Superintendent, Royal Botanic Gardens, Calcutta, who has kindly sent the following information :—

Copy of letter No. 1372 dated the 20th November, 1899, from the Secretary, Bengal Chamber of Commerce, to the Reporter on Economic Products to the Government of India.

"I have the honour to acknowledge receipt of your letter No. 2726 of 10th November, enclosing copy of an extract from a letter dated 30th August 1899, from a correspondent in Jamaica, asking for certain information regarding the preparation of Ballam trade rice.

"2. I have consulted several of the principal shippers of this rice to the West Indies and the concensus of replies is to the same effect, viz., that Ballam trade rice as shipped to England, is always subjected to a treatment of boiling before being hulled. Large and small producers all treat the rice in the same fashion which as far as I can gather, is not an elaborate process of steaming, but is conducted in the open air in the most primitive fashion."

COCOA AT GUAYAQUIL.

A correspondent at Guayaquil sends the following notes on Cocoa growing there:—

"Though not directly interested in the cultivation of cocoa, I have for many years watched it carefully and have noted that although the tree flourishes in almost any bank of alluvial soil, it only produces well when the said soil reaches a depth of not less than twelve feet as a minimum ; when planted in a situation where the tap root enters sand or gravel, the tree attains its usual height and throws off copious foliage but seldom gives even a mediocre crop of pods ; in fact there are two zones in the heart of the most productive portion of the upper river cocoa region here in which an average crop is only obtained after a very copious and long continued rainy season *i.e.* once in seven years more or less and in this region I have found ancient river beds extending right along the unproductive portion with sand and gravel within six to ten feet of the surface.

"The best cocoa grows where a rich fat red alluvion is struck and the average crop here is considered good when an orchard produces one pound of marketable cocoa per tree. The tree is delicate and requires considerable shade; though, if abandoned or uncared for, it does not die off, even though enveloped in tropical vegetation, and if the vicinity be cleared off, begins to produce just as soon as it is allowed ventilation

again. No one here has treated the tree to any kind of scientific culture and notwithstanding the fact that the same soil has been cropped consecutively for over a hundred years there is as yet no sign of decadence nor does a necessity yet arise for artificial manure.

"There have been a few instances of a disease due to a small insect which perforates the pod and stops its growth, but this has only occurred in very dry seasons and in the lower region of the country, but otherwise there has been no disease which has attacked the tree or fruit here ; a failure of the crop is almost invariably due to either a very dry season with strong sunshine shrivelling up the flower, or to a very heavy rainy season in which the tree is often enveloped in water for several weeks at a time to a height of several feet over the surface of the ground ; in the last case the pod though well formed becomes black and drops off with the seed rotten.

"You will excuse me for entering on these matters, as you are doubtless conversant with same, but I merely indicate them to you to explain our local cultivation which perhaps has not come directly under your observation."

SOME CONSTITUENTS OF THE LEAVES OF RHUS METOPIUM, AND HAEMATOXYLON CAMPEACHIANUM.

By A. G. Perkin, F.R.S.E., of the Clothworker's Research Laboratory, Yorkshire College, Leeds.

Rhus Metopium, Linn.*

A re-investigation of the colouring principle present in the leaves of the *Rhus Cotinus* and *Rhus Coriaria* (*Journal Chem. Soc.* 1896, 1299 and 1898, 1016) has shown that this is not quercetin as stated by Löwe (*Zeit. anal. chem.* 1874, 12, 127) but myricetin. Quercetin however is found in the leaves of the *Rhus rhodanthema* ** (New South Wales) and an interesting point with regard to both this plant (*Journal Chem. Soc.* 1897, 1194) and the *R. Cotinus*, is that their stems contain a distinct colouring matter fisetin. Research has indicated that quercetin $C_{15}H_{10}O_7$ and myricetin $C_{15}H_{10}O_8$ are respectively hydroxy-and dihydroxy-derivatives of fisetin $C_{15}H_{10}O_6$ and it thus follows that the leaves of these plants contain the colouring matter of the stem in a more oxidised form. In some cases a relationship can be traced between the tannin and colouring matter which co-exist in the plant by means of their respective decomposition products but as in certain instances exceptions occur, no rule can be laid down on this point. It is interesting to note however that myricetin and gallo-tannin both derivatives of pyrogallol are frequently found together, and that the same is the case with quercetin which is a catechol compound, and the catechol tannins. In

* [Metopium Linnaei, Engl.]
** [Rhodosphaera rhodanthema, Engl.]

continuation of this work it was interesting to examine the leaves and stem of the *Rhus Metopium* and I am much indebted to Mr. W. Fawcett, Director of the Department of Public Gardens and Plantations, Jamaica, for a very liberal supply of the raw material.

To isolate the colouring matter an aqueous decoction of the leaves was treated with lead acetate solution and the resulting pale yellow precipitate containing the lead compound of the colouring matter, was collected suspended in boiling water and decomposed with dilute sulphuric acid. The clear liquid was decanted from the lead sulphate, agitated with ether, and the extract evaporated, a residue thus remaining which consisted of the colouring matter containing ellagic and gallic acids. After purification the colouring matter was obtained as yellow needles soluble in dilute alkalis with a deep green colouration and appeared to be myricetin; further experiment however indicated the presence of two substances. Thus the acetyl compound prepared in the usual manner had no definite melting point, and on analysis gave numbers intermediate between those required by acetyl-quercetin and acetyl-myricetin (C=57.25; H=4.51). In order to separate the mixed colouring matters, the acetylised product obtained from them, was fractionally crystallised from alcohol, a process suggested by the sparing solubility of acetyl myricetin in this solvent. The more insoluble portion was eventually obtained as colourless needles melting at 204°-206°. Analysis gave, C=56.87; H=4.17.

$C_{15}\ H_4\ O_8\ (C_2\ H_3\ O_6)$ requires C=56.84; H=3.86.

It was apparently *acetyl-myricetin*, and to confirm this a portion was converted into the free colouring matter by treatment with sulphuric acid and analysed C=57.03; H=3.45.

$C_{15}\ H_{10}\ O_8$ requires C=56.60; H=3.14.

Thus obtained, the colouring matter formed glistening yellow needles having the dyeing properties and characteristic reactions of *myricetin*. The amount contained in the leaves is approximately 0 1 per cent. The identification of the second colouring matter was difficult, it being by far the minor constituent of the mixture. By repeatedly recrystallising the more soluble portion remaining after the isolation of the acetyl-myricetin, a fraction was obtained melting at 189°-191° closely resembling acetyl-quercetin. On decomposition with sulphuric acid this however yielded a colouring matter soluble in alkaline solutions with a pale green colouration, indicating still a trace of myricetin, for quercetin dissolves in this manner with a pale yellow tint. By the action of bromine quercetin yields debrom-quercetin which is sparingly soluble in alcohol, whereas myricetin thus forms a compound of a readily soluble nature, and these reactions suggested a method for their separation. The colouring matter as above purified was therefore treated with bromine in the presence of glacial acetic acid, and the product after standing twenty four hours crystallised from alcohol. It consisted of yellow needles melting at 237°-239° and was evidently *debrom-quercetin*. A further confirmation of the presence of *quercetin* in the mixed colouring matters was obtained by decomposing a trace with fused alkali, when *protocatechuic acid* and *phloroglucinol* were identified as present in the products of the reaction. Owing to the small quantity contained in the leaves further tests could not be carried out.

The late Professor Henry Trimble has found the tannin present (private communication) to be gallo-tannic acid. For an analysis of the leaves I am indebted to Professor Procter of the Yorkshire College, Leeds.

Tanning matters absorbed by hide	8.2	per cent.
Non-tanning matters	13.0	"
Insoluble at 60 F.	68.5	"
Water	10.3	"
	100.0	"

The constituents of the leaves of the *R. Metopium*, closely resemble those of the *R. Coriaria*, *R. Cotinus* and *R. rhodanthema*, in fact the chemical examination may be said to confirm the classification of the botanist. Thus

		Colouring Matter	Tannin.
R. Coriaria	contains	Myricetin	Gallo tannin
R. Cotinus	„	Myricetin	Gallo tannin
R. Metopium [Metopium Linnæi]	„	Myricetin & Quercetin	Gallo tannin
R. rhodanthema [Rhodosphæra rhodanthema]	„	Quercetin	Gallo tannin

The stem of the R. Metopium was found to be devoid of colouring matters of the quercetin group, but gallo and ellagi-tannic acids were present.

The Leaves of Haematoxylon Campeachianum.

As is well known, the stem of this plant constitutes the dye-stuff logwood, and it was interesting to determine if a colouring matter was present in the leaves, which possessed a close chemical relationship with the haematoxylon of the stem. Such has already been shown to be the case with the colouring matters contained in the stem and leaves of the *Rhus Cotinus and R. rhodanthema (loc. cit.)* For asupply of the leaves I am indebted to the kindness of Mr. W. Fawcett, Director of Public Gardens and Plantations, Jamaica. Examination revealed the presence of a yellow colouring matter which could be isolated in a similar manner to that present in the *R. Metopium*. It formed glistening yellow needles soluble in dilute alkalis with a pale green colouration, indicating some yellow colouring matter contaminated with a trace of myricetin. Analysis gave numbers agreeing with those required by quercetin. C=59.51; H=3.64.

Theory for $C_{15}\ H_{10}\ O_7$ —C=59.60 ; H=3.31. per cent.

That it consisted almost entirely of this colouring matter appeared evident by the examination of its acetyl-derivation which was obtained as colourless needless melting at 191°. Analysis gave C=58.36; H=4.30.

$C_{15}\ H_5\ O_7\ (C_2\ H_3\ O_5\ )$ requires C=58.59; H=3.90.

Further, on decomposition with alkali the colouring matter yielded *phloroglucinol* and *protocatechuic* acid. The amount of quercetin contained in the leaves was approximately 0.3 per cent. The substance accompanying the quercetin, soluble in alkalis with a green colouration, could not be isolated owing to the small quantity present. It could however be removed from the quercetin by treatment with bromine and crystallising the product from alcohol. The debrom-quercetin thus obtained melting at 232°-234°, was reconverted into quercetin by digestion with hydriodic acid, and was now soluble in alkalis with a pure yellow colouration.

The Tannin. As experiment indicated the presence of a considerable quantity of a tannin in these leaves, it was desirable to isolate and submit this to examination. The leaves were extracted with boiling alcohol, the extract evaporated to a small bulk, poured into water and treated with ether to remove wax and chlorophyll. From the brown aqueous liquid after saturation with salt the tannin was extracted with ethylic acetate and thus obtained in the form of a sticky brown mass. This was dissolved in water and the solution treated with salt, which caused the precipitation of a viscous brown impurity which was removed by agitation with bibulous paper and filtration. From the clear liquid the tannin was removed by ethylic acetate, and on cautiously evaporating this solution was now obtained as a pale yellow friable mass. An analysis gave C=53.15 ; H=4.02 numbers which are in close agreement with those required by *gallo-tannic acid.* As it gave a blue green colouration with ferric chloride in aqueous solution, and *gallic acid* by digestion with boiling dilute sulphuric acid its identity with this substance was confirmed. Bromine water gave no precipitate indicating the absence of a catechol tannin.

The constituents of the leaves of *Haematoxylon campeachianum* are thus *quercetin,* a trace of a second colouring matter which is probably *myricetin,* and gallo-tannic acid. There is no direct relationship between quercetin, the colouring matter of the leaves, and the haematoxylin which exists in the stems ; on the other hand it is interesting to note that both gallo-tannic acid and haematoxylin are derivatives of pyrogallol.

The chemical examination indicated that these leaves might constitute a serviceable tanning agent, and application was therefore made to Professor Procter who kindly undertook to study their properties in this respect. He reports as follows.

Tanning matters absorbed by hide	9.5	per cent.
Soluble non-tanning matters	17.5	"
Insoluble at 60° F.	62.8	"
Water	10.4	"
	100.0	"

The tanning strenth* 9.5 per cent. is too low to allow of their pro-

* The sample of leaves employed was collected, for the author with no special idea of their examination as a tanning agent, and evidently being slightly brown at a somewhat late period of the season. As a sample of selected leaves analysed by Professor Procter gave 11.2 per cent. of tanning matter, it is to be presumed that if collected at a suitable period their tanning content will be greater than that given above.

fitable exportation in the leaf form ; the colour of the leather tanned by them however is by no means bad, and if a satisfactory extract of not less than 25 per cent. strength can be produced from them, this would nc doubt find a market in this country.

NOTE, by DR. BUCHER, W. Indies Chemical Works, Ltd., Spanish Town

Gallo-tannic acid, in a more or less impure form is used largely in the tanning and dyeing industries. This body is found plentifully in a great variety of plants. Whilst gall-nuts or galls, worth 62 pounds sterling per ton, contain some 70 per cent. of this tannin, air dry sumach (*Rhus Coriaria* and *R. Cotinus*), worth £8 per ton, contains some 25 per cent. Gallotanic acid is easily extracted in a pure state from galls, whilst sumach contains a small amount of a yellow colouring matter, which lowers the value of the tannin.

Green logwood leaves contain 60 per cent. of water, and would contain in deduction from Professor Procter's analysis, but a trifle over 4 per cent. of gallo-tannic acid. The fact of logwood leaves containing a yellow colouring matter besides the tannin would detract from their value. It is questionable whether an extract from logwood leaves could compete with sumach, or an extract from sumach. An extract from logwood leaves, at 51 ° Tw., the usual commercial density, would not contain more than 19 per cent. of tannin.

A NEW PACKING MATERIAL FOR FRUITS.

An interesting experiment has just taken place in the matter of packing fruits in the Colony of Victoria for shipment to England.

As is pretty generally known, Apples and Pears are now brought from the Cape of Good Hope and from Australian colonies in boxes holding a bushel, which are stored on board ship in cool chambers. These chambers, or refrigerators, have been provided by the steamship companies at a considerable outlay of money. The fruits are merely wrapped in tissue, and placed in the boxes.

Under this system, apples have for the most part come very successfully; but pears have been less satisfactory. Occasionally, there have been Pears from the Antipodes that have reached this country in a sound condition, but numerous consignments have proved to be of little value, and the commission agent is never able to speak of such fruits or to gauge their value until they have been unpacked. The freight per bushel from Victoria to London for Apples or Pears so packed and stored on board ship in cool chambers is 3s 9d.

Such are the circumstances of the present system, and the amount of freight paid for passage.

And now for the experiment for intelligence of which we are indebted to Mr. J. B. Thomas, a well known fruit salesman in Covent Garden, to whom the fruits which have been the subjects of experiments were addressed.

Instead of packing the apples wrapped in tissue only, in the case of several bushels that have recently arrived in London by the S. S. Wakood, a quantity of asbestos or a preparation of this substance has been used. The fruits were wrapped in tissue as formerly, and afterwards embedded in the asbestos, each fruit being perfectly surrounded by this substance. Upon unpacking the case, the asbestos appeared to be caked, but it was easily broken up, and then appeared almost like flour. We should suppose, therefore, that the fruits would be air tight under such conditions, and this will account for the fact that as we saw them they were perfectly sound, and in excellent condition, although five months had elapsed since they were packed in the boxes. The apples were grown by Mr. J. R. Warren, Mount Alexander Orchard, Harcourt, and Mr. J. M. Ely, Rosehill Gardens, Harcourt, both large Victorian fruit growers. They were packed and brought to this country under the direction of Mr. Geo. Pontin, Church House, Yapton, Sussex. The apples were gathered and packed previous to May 5th last, but owing to some objection, we believe, on the part of the steamship companies, there was a delay of two months or more before shipment, and even then they travelled by the Cape route. The companies, naturally perhaps, object to the introduction of a new system of packing fruits that may render unnecessary the cool chambers that have cost so much money to provide. But such objections will, no doubt, be overcome, and if a syndicate be formed, as is now proposed, the system will be given a conclusive trial. The new system should it answer to expectations, will possess several advantages. The fruit may then be stored in the " hold of the ship, and the freight per bushel-case will be 6d. instead of 3s. 9d. ; but as the packing material will displace a quantity of the fruits in each package, it may be well for present purposes to describe the future freight of the fruit as 1s. per bushel.

It must be remembered also that the asbestos is a valuable material in England, and it will be sold here to as much advantage as will the apples. The result will be that the asbestos and fruit would be brought to England for less money than is now paid for the fruits alone. The apples will travel as well or better, and it is thought they may be preserved after arrival here for weeks if necessary, providing that the cases be not opened in the meantime. And beyond the other considerations, it is hoped also that Victorian Pears by this system may be placed on the English market without much risk of loss by decay.—(*Gardeners' Chronicle.*)

COMPOSITION OF BANANAS AND PLANTAIN FRUITS. *

The changes that take place in the banana fruit during the successive stages of its growth and ripening are described by Dr. Warden in the Dict. Econ. Prod. of India, Vol. V., p. 301:—

"The composition of the banana at different stages of maturity has been investigated by Ricciardi. The green fruit contains over 12 per

* Extract from Bulletin of Miscellaneous Information, Royal Gardens, Kew, August, 1894, pages 305—310.

cent. of starch, which disappears as the fruit ripens. It contains 6.53 of tannin and the ripe only .34 per cent., so that as the fruit ripens this principle disappears, and this is also the case with the other organic acids which are present. The sugar in the fruit which ripens on the tree is almost entirely cane sugar, but in the fruit cut and ripened by exposure to air the invert-sugar reaches about 80 per cent of the total, while the cane sugar is reduced to about 20 per cent., calculated upon the sugar present. Proteid substances (albuminoids) are present in the green fruit to 3.04 per cent., and in the ripe to 4.92 per cent. The green fruit yields 1.04 and the ripe .95 per cent. of ash, which contains 23.18 per cent of phosphoric anhydride, and 45.23 per cent of potash."

The use of plantain meal as an article of food is doubtless of great antiquity. It is frequently mentioned by old authors. Rumph records that in the Malay archipelago "man begins life with plantain" as the meal is used for making pap for new born infants.

In the Dict. Econ. Prod. of India, Vol. V., p. 300, the same point is more fully stated:—

"It is interesting to notice that the large crop of food produced by bananas and plantains may be preserved for an indefinite period either by drying the fruit or by preparing meal from it. Both of these processes, which have long been known and carried out in the West Indies and South America, are also carried on in India, though to a much smaller extent. Linschoten notices the practice as common in the sixteenth century, writing,—'these grow much in Cananor, in the coast of Malabar, and are by the Portingales called figges of Cananor, and by reason of the greater quantities thereof are dried, the shells being taken off, and so being dried are carried over all India to be sold.' When the nearly ripe fruit is cut into slices and dried in the sun a certain part of the sugar contained in the fruit crystallizes on the surface and acts as a preservative. The slices thus prepared, if made from the finer varieties, make an excellent desert preserve, and if from the coarser may be used for cooking in the ordinary way. They keep well if carefully packed when dry, and ought to form a valuable antiscorbutic for long voyages. The fruit may also be similarly preserved whole by stripping off the skin and drying it in the sun. Plantain meal is prepared by stripping off the husk, slicing the core, drying it in the sun, and when thoroughly dry reducing it to a powder, and finally sifting. It is calculated that the fresh core will yield 40 per cent. of this meal, and that an acre of average quality will yield over a ton."

A good account of plantain meal and its value for food purposes was published by Professor Johnston in the Transactions of the Highland Society, No. 20. This was reproduced in the Barbados Agricultural Report, August 8th, 1848.

The inquiry was started by the receipt of a sample of plantain meal sent to Scotland from Surinam or Dutch Guiana. It is remarkable that after an interval of about 50 years the starting of a factory for the manufacture of plantain meal in the same Colony should once more bring the subject into notice.

Professor Johnston says: "Plantain Meal is of a slightly brownish colour, and has an agreeable odour, which becomes more perceptible

when warm water is poured upon it, and has a considerable resemblance to that of orris root.

"When mixed with cold water, it forms a feebly tenacious dough more adhesive than that of oatmeal, but much less so than that of wheaten flour. When baked on a hot plate, this dough forms a cake which is agreeable to the sense of smell, and is by no means unpleasant to the taste. . . . . .

"When boiling water is poured over the meal it is changed into a transparent jelly, having an agreeable taste and smell. If it be boiled with water it forms a thick gelatinous mass, very much like boiled sago in colour, but possessing a peculiar pleasant odour."

In the plantain "while green, the heart is white and insipid; the starch predominates, and it scarcely contains any sugar. In this state it is roasted in the ashes, and at table takes the place of bread, potatoes, maize and other farinaceous food. In South America they are dried entire in ovens, and become hard, brittle, and trans-lucid like horn. Under the name of 'fifi' they are, in this state, taken as travelling stores in sea voyages and long journeys by land."

The starch of the arrow-root, cassava, and of the ordinary potato is easily extracted, but according to Dr. Shier, the starch from the plantain (in the unripe state) cannot be extracted in a perfectly white condition, in consequence of being associated with a colouring matter from which it is almost impossible to separate it. This colouring matter resists the action of the most powerful bleaching re-agents.

In 1890 analyses of the unripe banana and plantain fruit were published by Messrs. Harrison and Jenman (Report on Agriculture, British Guiana, p. 59):—

"Composition of a Sample of Bananas. (unripe)

		Dried.	Fresh.
Water	...	5.75	75.11
Oil or fat	...	.69	.18
Sucrose	...	None	—
Glucose	...	1.75	.39
Starch	...	42.11	11.11
*Albuminoids	...	5.13	1.35
Gums, etc.	...	1.88	.36
Digestible fibre	...	36.87	10.07
Woody fibre	...	2.52	.66
Ash (mineral matter)	...	3.30	.87
		100.00	100.00

* Containing nitrogen, dried .84, fresh .22

"Though the food elements in the banana vary from those of the plantain, the sum total of them is much about the same. The plantain is decidedly richer in starch and glucose, while the banana excels in albuminoids and digestible fibre. The advantage in value is with the plantain."

"The following analyses of the common plantain, fresh and dried

respectively, are closely representative of the character of all varieties. Plantains are essentially a starchy food, deficient in albuminoids and fats :—

"Composition of Sample of Common Plantains.

" Fleshy matter or pulp, 64.5 per cent., skin, 35.5 per cent.

	Fresh Pulp.	Flour from Dried Pulp.
Water	62.86	11.80
Fats ...	.44	1.05
*Albuminoids ...	1.58	3.75
Glucose ...	2.25	5.34
Starch ...	22.16	52.64
Tannin, gum, etc. ...	.50	1.20
Digestible fibre ...	9.01	21.37
Indigestible fibre ...	.40	.95
Ash (mineral matters) ...	.80	1.90
	100.00	100.00

*Containing nitrogen, fresh pulp .25, flour from dried pulp .60."

A valuable paper on the chemistry of the banana was published by the late M. B. Corenwinder in Annales Agronomiques, ii. (1876). pp. 429-445. His main results were obtained from a bunch of 107 fruits sent to him from Brazil in August 1875. The bunch was a month in transit to Lille. He found 34 per cent. of peel and 66 per cent. of pulp. His best fruits, while sound, gave 15.9 per cent. of sucrose and 5.9 per cent. of glucose. His worst gave 2.84 per cent. of sucrose and 11.84 per cent. of glucose

Corenwinder gives the following complete analysis of the pulp (p. 436):—

Composition of fresh Brazilian Banana (pulp only).

Water	72.4
Sugar (sucrose)	15.90
Sugar (glucose)	5.90
Cellulose	.38
*Albuminoids	2.13
Pectose	1.25
Oil, etc.	.95
Ash	1.03
	100.00

*Containing nitrogen .34.

The composition of the ash from the pulp is given by Corenwinder. In the opinion of Professor Church, there is a possible mistake here in regard to the magnesium carbonate present.

Mineral composition of the ash from the pulp of the Brazilian Banana.

Potassium sulphate	...	3.61
Potassium chloride	...	14.34
Magnesium phosphate	...	8.24
Potassium phosphate	...	27.12
Potassium carbonate	...	41.66
Magnesium carbonate	...	6.54 ?
Calcium carbonate	...	1.17
Ferric oxide	...	0.36
Silica	...	2.96
		100.00

In the South Kensington Museum Handbook on "Food" (reprint of 1893, p. 135) Professor Church, F.R.S., gives an analysis of fresh peeled bananas (apparently nearly, if not quite, ripe). This affords information on a point not already discussed. The bananas were those usually sold in shops in this country, and it is not improbable they were Canary bananas yielded by Musa Cavendishii.

"Fresh-peeled bananas contain :—

		In 100 parts.	In 1lb. oz.	grains
Water	...	73.9	11.	361
Albuminoids, etc.	...	1.7	0	119
Sugar and pectose		22.8	3	283
Fat	...	0.6	0	42
Cellulose	...	0.2	0	14
Mineral Matter	...	0.8	0	56

The nutrient ratio is here 1.14 ; the nutrient value is 24."

The "nutrient-ratio" amongst the nutrients of daily food is that between the albuminoids or "flesh-formers," and the carbohydrates plus the fat reckoned as starch, or "heat-givers." In the standard dietary adopted it is 1 : 4¾.

For the sake of making a rough comparison between various foods it is a convenient plan to add together the per-centages of albuminoids, starch, dextrin, and sugar, and the starch equivalent of any fat present. The sum of these constituents is called the "nutrient-value"; this value is that of 100 parts.

A further sample of ripe bananas (a variety of M. sapientum) grown in the Palm House at Kew was submitted to Professor Church in May last. The results of his analysis are as follows :—

Water in pulp	68.3	per cent.
Dry matter in pulp	31.7	"
Albuminoids, calculated from total nitrogen in pulp	1.515	"
True albuminoids in ditto by phenol method	1.03	"

"The latter figures seem to show that one-third of the nitrogen in the just-ripe pulp exists in non-albuminoid forms."

The most recent analysis of meals are those lately made for Kew by Professor Church, of a sample received through Messrs. Lee, Crerar, and Co. from Jamaica, and called "banana" meal, although it is quite possible it may have been prepared from unripe plantains. The other samples were from Surinam. The latter were particularly stated to be derived from the fruit of the banana (Musa sapientum.)

Professor Church's analyses of these samples, with explanatory notes are given below :—

Professor A. H. Church, F.R.S., to Royal Gardens, Kew.

Shelsley, Kew Gardens,

February 16, 1893.

Dear Mr. Morris,

I have arranged in the table which follows, the results of my analyses of some of the banana meals which you handed to me for examination. The Jamaica sample is designated by the letter A. ; the Surinam sample of the meal made from the interior of the fruit of Musa sapientum by the letter B. ; and the meal from the peels of the same fruit by C.

Per-centage Composition of banana meals.

	A Jamaica.	B Surinam.	C Surinam.
Water ...	15.5	14.3	13.1
Albuminoids (true) ...	2.5	2.3	3.3
Starch, sugar, gum, etc.	77.7	79.5	58.7
Oil ...	1.0	.7	5.5
Fibre ...	.7	.9	8.7
Ash ...	2.6	2.3	10.7
Nutrient-ratio ...	1.32	1.35	1.22
Nutrient value ...	82	83	74

It is noticeable how widely the nutrient ratio (or proportion of albuminoids to starch plus the starch-equivalent of the oil) diverges in all these meals from the ratio of the perfect food, which should show the proportion of about one to five. In the analyses by Mr. L. E. Asser the above divergence seems less marked, for he has calculated the whole of the nitrogen present as if it existed in the albuminoid form. I find that this is far from being the case. In this Surinam sample 2 (B. above) 71 per cent. only of the nitrogen present is albuminoid, in his sample 5, made from the peels, 77 per cent. In other respects my results and his agree well.

I would further remark that sample 4 (from Jamaica) was probably made from fruits still more unripe than those which were used in the preparation of B. and C. For in this meal no more than 56 per cent. of the total nitrogen exists in the albuminoid form, the remaining 44 per cent. being present in the less highly elaborated state of amides, etc., the food value of which is either nil or very slight.

In all the above samples starch is more abundant than sugar ; the proportion of the latter increases as the fruit ripens.

The constituent set down as "oil" in the table of analyses is the ether-extract of the meals. In the case of C, the meal prepared from the peels, it consists partly of wax and colouring matter.

In the ash of the meal prepared from peels a notable quantity of manganese was found. Traces of copper occurred in all the samples.

Yours truly,

(Signed) A. H. Church.

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Arenga Engleri
Strychnos angustiflora
Melastoma sanguineum
M. candidum
Bauhinia acuminata
Reevesia thyrsoidea
Caesalpinia vernalis
Eugenia buxifolia
Lonicera longiflora
Camellia reticulata
Aristolochia Togala
Aleurites cordata

From Public Gardens Nagpur

Bignonia gracilis

From R. Botanic Gardens, Sibpur

Bambusa arundinacea
Marlea begonifolia
Phoenix humilis, var. Loureirii
Acrocarpus fraxinifolius
Abroma angusta
Helicteres Isora
Hibiscus cancellatus

From R. Botanic Gardens, Trinidad.

Sabal acaulis

From R. Botanic Gardens, British Guiana.

Castilloa elastica

From Messrs Dammann & Co. Italy.

Bergamot

[Issued 22nd March 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series | March, April, May, 1900 | Vol. VII Parts III-V

TEACHING AGRICULTURAL PRINCIPLES IN SCHOOLS.

The Director of Public Gardens read some notes on the subject of teaching agricultural principles in schools at the Agricultural Conference at Barbados last January, pointing out that such teaching should consist of practical work and experiment, and that no books should be put into the hands of the children, but that they should as far as possible themselves carry on the experimental work. Several instances were given of the kind of experiment that would be useful.

Since the Conference a small book has been published by Messrs. Macmillan of London and New York, which can be strongly recommended for use by teachers for the purpose. It is entitled, "The Nature and Work of Plants: An introduction to the study of Botany." The author is Dr. D. T. MacDougal, Director of the Laboratories in the New York Botanical Garden.

To those who do not know how the study of botany has been revolutionised during the last 30 years, it may seem strange that a book on botany should be recommended as a first step in teaching agriculture. However when it is stated that the new way of studying botany is to look upon each plant as a living creature and to watch its life and the influences that affect it, it will be recognised how indispensable the study is to all those who have to deal with plants in earning their livelihood.

The course outlined in this book is essentially a study of the functions or action of the plant, and the organs are considered chiefly as instruments for the performance of work with but little attention to their morphology. The apparatus needed to carry out the experimental work may be found in any household with the exception of a hand lens magnifying 6 to 10 times, which may be purchased for one or two shillings.

The headings of the chapters are:—

I. The Composition and Purposes of Plants; II. The material of which Plants are made up; III. The manner in which different kinds

of work are divided among the members of the Body ; IV. The Roots ; V. The Leaves ; VI. Stems ; VII. The Way in which new Plants arise ; VIII. Seeds and Fruits ; IX. The Power or Energy of the Plant ; X. Relations of Plants to each other, and the place in which they live.

As an example of the style of the book, the following paragraphs are quoted :—

" *Wilting.* If the leaf of any rapidly growing plant is taken off and laid in the sun for an hour, it may be seen that it becomes limp and is said to be *wilted.* Compare with a fresh leaf. It is quite flexible, and the soft tissues between the ribs appear to be shrunken. Hold an end of the leaf in either hand and pull until it breaks in two parts. Repeat with a fresh leaf. The wilted leaf is as strong in this way as the fresh one. It has not lost any of its mechanical tissues, and its limpness must be due to the loss of water. The cells of fresh leaves of the plant are filled with water to such extent that they are stretched and the walls are very firm, in the same manner that the string of a bow is as rigid as a bar of iron when the bow is prepared for use, but quite limp and flexible when separate.

" At noonday in midsummer and at other times the leaves do not receive as much water as they evaporate, and as a consequence they wilt more or less. The wilting is itself a protection against serious injury, for in this condition the openings on the lower surface of the leaf are closed, and the drooping position assumed by the blade operates to diminish the amount of water thrown off into the air.

" *Transplanting trees and herbs is attended by wilting*:—A plant usually develops a system of roots with hairs capable of supplying the necessary amount of moisture to the leaves, and when it is lifted from the ground the process is attended with more or less damage to the roots or hairs. When the plant is set in a new position its absorbing powers are not so great as before, and if it is allowed to retain all of its leaves, it will throw off more water than it receives, and wilting will result. To avoid this the branches are trimmed in such manner as to reduce the evaporating surface to the proper proportion to the roots. One may see nurserymen putting out trees, the tops of which have been trimmed to bare poles."

At the English Education Exhibition last January at the Imperial Institute, a series of Conferences of Teachers was held, and at one of these Prof. Miall, F.R.S., of the Yorkshire College, read a paper on the teaching of botany. He gave it as his opinion that there is hardly any scientific inquiry which was at once so practical and inviting as that of botany. A special reason for encouraging the study of botany was that a knowledge of the great facts of plant life was essential to scientific agriculture. Those who lived by agriculture which was still our greatest industry, were already beginning to demand that, in the rural schools at least, the scientific basis of agriculture should somehow enter into the course of instruction. But botany as at present taught was a kind of book-learning, and teachers were convinced this could not continue without very serious loss to the pupils. They were all agreed that the teaching of botany must be thoroughly practical, and as far as possible,

experimental. From the beginning it must take the form of inquiry, which at the present moment was not the case. There was now no real investigation; pupils were not brought in direct contact with facts, or encouraged to think for themselves. In short, the present system of teaching botany was bad, and it was a lamentable thing that the young persons who were growing up to live by the farm or the garden were growing up ignorant of scientific method, and practically ignorant whatever verbal knowledge they had picked up, of those natural processes which rendered possible the raising of crops and the rearing of stock. In dealing with the place the teaching of botany should take in the school course he expressed regret that under the present system so many subjects were crowded into it that nothing could be well taught.

ENSILAGE WITHOUT PRESSURE.

By Dr. Ross, Kenmore, N. S. Wales. *

The subject of ensilage has received such adequate treatment at the hands of various writers in the columns of the *Agricultural Gazette*, that it is not proposed in this short article to give more than the experience of the past four years in ensilage-making at the Hospital for the Insane, at Kenmore, near Goulburn.

The material each year has been maize, and maize only, of no special variety, cut when the cobs were in the milky stage, and the tassels full, though not faded. The seed has been variously planted—broad-cast and drilled—and we believe in the latter, using about 1-12 bushel to the acre. The soil throughout is decidedly poor, and un-aided would now, after four years use, probably yield next to nothing. To make amends for lack of quality, deep ploughing and intense cultivation generally have been the rule, with the result that during the period mentioned—an exceptionally droughty one—there have been returns far exceeding those gained by others who took less pains.

The methods employed for storing the maize has invariably been the stack—which is equally good for large or small quantities—making respectively in the years 1897, 1898 and 1899, 5, 300, and 150 tons with a prospect this year of at least 400 tons.

The stack has for a platform at its base posts and rails, unserviceable for their ordinary use, simply placed on the ground, which is raised a few inches to prevent surface water from doing damage either directly or by upward soakage. A shallow ditch surrounds the platform to ensure the above.

The maize is cut either with sharpened spades or with short scythes. The former is, perhaps, the better tool, as it allows of the stalks being cut quite close to the ground, but both these methods are about to be superseded by using a maize reaper and binder. The cut stalks are carted as speedily as possible to the stack, which should be in some central position, and some pretence is made of placing the cut ends of the

* Agricultural Gazette, N. S. Wales.

stalks outwards, and although this should be done consistently to make the stack as square and as solid as possible on the outside, it has not been found necessary on any other ground. In the body of the stack the stalks may be placed anyhow.

The number of hands employed on the stack depends altogether on its size and the rapidity with which the material is delivered. When the stack has grown too high to hoist the stalks with a hay fork, an ordinary jib is fixed, worked by a horse, and the ultimate height of the stack is determined according to the height of the pole to which the jib is attached.

Generally speaking, the stack should be as square as possible, by which means the greatest pressure by the material itself is procured.

No attempt to guage the heat of the stacks at any period of their existence was made, except, perhaps, in a casual way by the hand.

It has been found, however, in practice, that on a stack 24 feet square at its base, if the material is placed upon the stack at the rate of more than 25 tons a day, there is a tendency for the layers nearest the ground to get more than their share of the pressure, the result being sour ensilage at that particular part of the stack.

Finally, when the stack is made as high as possible—say 25 feet a few posts and rails, answering to the description before given, are placed on top, merely to prevent the wind from disturbing the top layers. In the course of about six weeks the height of the stack becomes reduced by its own pressure to about two-thirds of the original height.

Some covering to prevent rain from entering the immediate top of the stack is desirable, but not really necessary, as it is found that a certain loss occurs both at the top and sides of stack ensilage under any circumstances. The loss, however, is more apparent than real, because pigs will pick over the damaged material, and what they reject is left in their yards, and soon becomes a satisfactory manure. The ensilage made as described is sweet, with an appetising smell, which pervades the near neighbourhood, and is attractive to both man and beast. During the cold windy weather the ensilage has proved itself to be a food second to none, for, in addition to its nutritive qualities, the milk is of the best. The hospital herd are, in fact, an object lesson to the district.

It is but fair to add that the cows have, as additions to the ensilage either a small quantity of wheaten or oaten chaff or bran.

To sum up the experience gained here :—

1. That maize is an eminently satisfactory crop for the purpose.

2. The stack is an absolute success, except for the slight loss at the top and sides.

3. Pressure is not necessary.

4. It seems impossible to make bad ensilage under the circumstances described.

DISEASES OF TREES.

The relations of forest fires to insect ravages, insects to forest fires, diseases of trees to insects, and insects to fungous diseases are not obvious at first sight, but Dr. A. D. Hopkins shows in a report on the insect enemies of forests in the north-west, just issued by the U. S. Department of Agriculture (Division of Entomology), that there is a close connection, and, to a certain extent, inter-dependence,of all these factors in the destruction of valuable forest products. Trees dying from injury by fires, or weakened in vitality, offer favourable conditions for the multiplication of vast numbers of destructive insects. Moreover, trees which have been killed by insects furnish, in their fallen branches, standing and fallen partly decayed trunks, and dry bark, a most favourable condition for the starting, rapid spread, and perpetuation of forest fires. It is well known that forest trees weakened by disease contribute to the multiplication of their insect enemies; therefore the study of the insects associated with unhealthly forest trees should lead to results of economic importance. As an example of insects contributing to the spread of fungous diseases, Dr. Hopkins reports that the heartwood of the white fir throughout the region examined by him was commonly rendered worthless by decay as the result of wounds in the living bark made by Scolytus bark beetles.—(*Nature.*)

JAPAN WAX AND VARNISH.

JAPAN WAX.

This is afforded by several species of Rhus, the most important being R. succedanea, which flourishes especially in the W. provinces of Japan, as far as 35° N. lat.; second in order is R. vernicifera which extends to 38°.

The cultivated wax-tree (R. succedanea) was originally imported from Loo-Choo Islands, but growers now distinguish 7 different varieties. The tree flourishes in great abundance on the mountainous declivities of the island of Kiushiu, and in the provinces of Higo, Hizen, Chikugo, and Chekuxen, but less plentifully in Satsuma. It is planted along the road-ways, and around the edges of most cultivated fields, except rice-land when two years old, at distances of about 3 ft. between the stems; when set in squares,the interval is doubled. It is kept low by topping, and pruned to a pyramidal shape; propagation appears to be effected by shoots from the root. According to Simon, in the 5th year after planting, each tree gives 4lb. of berries, 6lb. in the 8th, 18lb. in the 10th, 40lb. in the 12th, 60lb. in the 15th, and declines after the 18th year; 4lb. of berries should yield 1lb. of wax.

The tree puts forth new leaves in April, blossoms in June, and ripens its berries in October to November. The berries are of the size of small peas, united in bunches; the wax is contained between the kernel and the other skin. The bunches are gathered, sun-dried for a few days, and stored in straw; when sufficiently mature, they are

threshed free of stems by means of bamboo flails. The process of preparing the wax much resembles the local method of husking rice. A wooden tilt hammer worked by hand falls into a wooden funnel-shaped trough containing the berries. In time, the husk and pulp of the berries are reduced to powder, while the kernel remains, and can be separated by a sieve. The mass is then dropped piecemeal from a height, a current of air being blown across the path of descent to remove the chaffy husk, which is afterwards collected and worked over again. In Sikok, it is said that a small percentage of inferior wax is obtained by grinding the kernels. The shifted and fanned powder containing the wax is steamed in hempen sacks laid on bamboo wicker-work, placed over a caldron. The sacks and their contents are then subjected to considerable force in wooden wedge-presses, and the wax that escapes is moulded for the market. Sometimes the flow of wax is hastened by the application of a little ye no-abara, the oil of Perilla ocimoides. The crude wax forms a coarse, greenish, tallow-like mass, amounting to about 15 per cent. (Sinon says 25) of the weight of the berries; it is thus used for making ordinary candles.

For special purposes, the wax is refined in the following manner. It is first melted, pressed through strong cotton sacks, and dropped into cold water, by which means it is produced in crumpled thin flakes, ready for bleaching in the sun. With this latter object, it is laid in shallow baskets 2½ ft. long and 1 ft. broad, placed in long rows numbering some thousands, in the open air. Here it is repeatedly turned, according to the intensity of the sun's heat, sprinkled with water, and melted again if necessary. It is then perfectly white.

For export, it is now often cast into large cubes weighing one picul (133⅓lb.) instead of the conventional saucer-shaped cakes 4-4½ in. diam. and 1 in. thick. The chief marts for the article are Nagasaki, Hiogo, and Osaka, whence it is sent largely to China, and in smaller quantity to Europe. The total exports were 1128 tons, £43,128., in 1874; the total value in 1875 was £37,249., and in 1877 about £47,250. The London market value is about 57-80s. a cwt. for ordinary, and 55s-67s. 6d. for inferior. It is often largely adulterated with water, which it takes up when melted with it to the amount of 30 per cent. It is extensively employed for making candles and wax matches; its melting point is 42°-55° (107°-131° F.); when old, it is soluble in boiling alcohol and warm ether, but separates on cooling. The cultivation of the shrub has been commenced in California.

Japan Varnish.

The natural varnish of Japan and China is derived from several species of Rhus, chiefly R. vernicifera whose fruits afford the Japan wax of commerce. The stems of the trees are incised at the age of 4-5 years, and the productiveness only lasts for 3 years. The implement used is a sort of double hook called kaki gama, with it a horizontal gash is first made in the bark, then an incision in the centre of the gash. The exudation is collected on an iron spatula, and poured into a vessel suspended from the collector's waist. The incisions are continued upwards till the whole tree has been wounded; it is cut down, the branches are lopped off, soaked in water for 10-20 days, and abundantly

incised. The product is most extensively employed in Japanese and Chinese lacquer-work. (Spons' Encyclopaedia.)

A few of each species can be distributed from the Public Gardens on application to the Director.

THE PROSPECTS OF CINCHONA.

Mr. Boehringer confirms the *Ceylon Observer's* view of the great encouragement now offering to cultivate cinchona—and especially hybrid cinchonas—in Ceylon. He points out that the bye-product, cinchonidine or cinchonine—at one time comparatively valueless—is now as much thought of as sulphate of quinine itself; and further that it is in Ceylon, rather than in Java bark such a bye-product is chiefly found. He would therefore advise the planting up of a hardy hybrid variety and there is every prospect of prices improving rather than going back, although already they are double what they were some time ago. The United States alone with Cuba, Porto Rico and the Philippines on their hands, are bound to be very large customers; but apart from this, quinine is now utilised in so many directions that a steady and growing consumption is assured. We would strongly urge Ceylon planters in the medium and higher and especially in the Uva districts, not to neglect the planting of cinchona.—(*Planting Opinion.*)

FERTILISERS FOR PINE-APPLES.

Conditions of soil, rainfall, etc., vary so much in Jamaica that it is important that experiments should be carried on in different districts with fertilisers for pine-apples and other products.

The following is a communication received from Mr. C. E. Smith Bog Walk, and it is hoped that others who are experimenting in any direction will contribute their results for publication:—

"I would not care to express an opinion as to the best fertilisers to use in Jamaica because the soils vary so greatly. Here in St. Thomas ye Vale I have experimented extensively with all sorts of ingredients and all kinds of combinations of the same. The severe storms of last fall made these experiments decidedly inconclusive but the best results I have so far obtained have been from 550 lbs. of Cotton Seed Meal per acre supplemented with 100 lbs. high grade (90 to 95 per cent.) Sulphate of Potash at time of flowering. I do not seem to get any results whatever from application of phosphoric acid. Of course I cannot say how it might be in other parts of the island. As a matter of fact I find the whole subject of fertilisers much more complicated here in Jamaica than on the comparatively barren sands of Florida. I feel that careful experiments are of great importance for I think it is easy to apply uselessly, expensive ingredients which are not required.

"Stable manure should never be used on pines—no matter how thoroughly rotted. I mean by 'stable manure' the droppings from

horses and mules; nor should that from poultry except as a liquid dissolved in water. The manure from cows and oxen may be used with splendid results. In Florida we used to 'Cow pen' our land. We would run a temporary fence about say an acre at a time and then every afternoon drive into it as many cattle as could be confined within the fence, keeping them there over night. This would be done for two or three weeks when the fence would be removed to enclose as much more land to be treated in the same way. This system of course had to be supplemented with the chemical elements but it supplied both humus and the most expensive ingredient, nitrogen.

"Above all no fertiliser should be used for pines in which the phosphoric acid has been rendered "available" by use of sulphuric acid. This seems to be poison to the pineapple. As I say above, my land shows no result from application of phosphoric acid. Other land may require it in which case I would advise use of the finest ground bone meal. It is also possible that the phosphatic guanos may do well. Personally I have had no experience with them."

The Florida Agricultural Experiment Station has published lately a Bulletin on this subject by Prof. P. H. Rolfs, a copy of which may be seen in the Director's office at Hope Gardens. A summary of these experiments was read by Prof. Rolfs before the Florida Horticultural Society as follows :—

Pineapple growing in Florida on an extensive scale is probably the youngest branch of horticultural industry in the State. For many years the growing of pines on a commercial scale was confined to the Keys and the West Indies. Various attempts were made to grow pineapples on the main land of Florida, but these all proved more or less unsuccessfull. I will not attempt to enumerate the causes for failure in this direction, but I may be permitted to mention in passing that the extension of the railroad down the East Coast is by no means the least important factor in developing this industry in that section. Of course pineapples were grown at various points along the East Coast before railroad communications were established, but the industry was carried on on a limited scale. The rapid transportation of fruit to Northern markets has stimulated the production.

GEOLOGICAL ORIGIN OF THE SOIL.

Geologists tell us that only a few periods of geological history have passed since Florida began to be. They tell us that the whole southern extremity of Florida, especially along the East Coast, has been gradually brought out by the sea. Coraline deposits in the ocean grew high enough to arrest the waves and form breakers. Upon these were deposited sand which finally grew high enough to make bars and islands. By the action of the wind the sand was carried higher, making our spruce pine land. By visiting our beaches we may see to-day where new land is being formed. This is bound into place and retained by the action of the beach plants, such as morning glorys and grasses. After these have flourished for a period of years the soil finally becomes suitable for palmetto scrub. After many years of growth the palmetto scrub adds enough humus to the soil to permit the spruce pine to form a forest. After these have grown for many decades the wood, falling

limbs, cones and debris generally give fertility enough to the soil to grow crubs—either the pine scrub, the hickory scrub or some other form.

PINEAPPLE LAND.

In pineapple growing as in other forms of horticulture the tiller of the soil has had to learn by dear experience what kind of land was best adapted to this particular crop. Our veteran pineapple grower, Captain Richards, has told us repeatedly how he attempted to grow pineapples upon the moist and fertile island soil. Finally ending in failure and almost despair, he planted a ew upon the sandridge on the west bank of Indian river at Eden. To his surprise this soil proved exactly what the pines wanted. From this small beginning we may say that practically the whole pineapple industry on the spruce pine land of the Indian river section had its origin.

FERTILIZERS.

In visiting the various sections of the Indian river country during 1897 diligent inquiries were made of the principal pineapple growers as to what forms of fertilizer they would recommend for use on pineapples. The enquiry ended in finding out that very few people agreed on using the same fertilizing substances. Those who mixed their own fertilizers seemed to be as much in doubt in regard to the action of particular substances as any one else. By far the greater number of pineapple growers, however, seemed to be depending upon ready mixed formulae for their use, the composition of these being in no case known. While the fertilizer houses always appended the percentage of nitrogen, potash and phosphoric acid present, there was no evidence as to the origin of the nitrogen, potash or phosphoric acid.

A few points in connection with fertilizing pineapples seem to be admitted by a considerable number of pineapple growers. However, there was no one form of nitrogen which was accepted by a majority of the extensive growers; and the same was true of potash and phosphoric acid. It was not difficult to find pineapple growers of more than local reputation who would condemn a certain form or forms of ammonia, and their neighbours would condemn certain other forms and probably advocate the use of the forms condemned by the first neighbour. By compiling the opinion of various growers every form of ammonia was condemned and the opposite of the proposition was also true; that is, every form of ammonia had its advocates. The same was true of potash Acid phosphate was quite generally considered a bad fertilizer. Of course everybody fertilized and everybody was dissatisfied with the action of certain forms of fertilizers. Very few were entirely satisfied with the forms of fertilizer that they were using, and the greater number of those who were satisfied with their fertilizer were people who had not been in the pineapple business very long.

OBJECTS OF THE EXPERIMENTS.

At this juncture the Experiment Station offered to set aside a certain amount of money from the Hatch fund to conduct experiments on a sufficiently extensive scale that they might be of value to the pineapple

growers. Application was made to various people interested for help in this connection. The Experiment Station agreed to purchase all fertilizers and superintend their application. The owner of the field was to furnish the labour, to cultivate it and receive the fruit when it had ripened on the field. Under these conditions many acres of pineapples were offered for experimental use. After making diligent inquiry into the condition of the fields and of the soil, it was finally decided that a field belonging to Ballentine & Moore, a mile north of Jensen, was the most suitable for the experiment work. Accordingly the work was commenced on the field, which had been set out in pineapples the previous July or August on recently cleared spruce pine land. Chemical analysis of the "pineapple soil" indicates very strongly that all the essential elements of fertility are wanting in it. Consequently it was thought that no plots would produce a good crop with an incomplete fertilizer. Therefore, the plots receiving an incomplete fertilizer were laid out in hundredth-acres, and plots receiving complete fertilizers were laid out in twentieth-acres. As many forms of nitrogen as were common on the market were secured ; also of potash, bone meal and dissolved Florida phosphate. Each form of nitrogen was combined with each form of potash and conversely. The phosphoric acid was used in this connection as extensively as the fund would permit.

The fertilizers used gave approximately the following formula :

Nitrogen	3 per cent.
Potash	7 per cent.
Available phosphoric acid	5 per cent.

The following amounts of fertilizers were applied February 7 and 8, 1898. A second application of two and a half times that amount was made June 27 and 28, 1898. A third application of one and a half times the amount was made November 4 to 12, 1898, at which time the photographs were taken.

Plot.	Ingredients.	Lbs. per Acre.
1	Cotton Seed Meal	800
2	Cotton Seed Meal	800
	Sulphate Potash, low grade	400
3	Cotton Seed Meal	160
	Sulphate Potash, low grade	400
	Bone Meal	1,600
4	Cotton Seed Meal	160
	Bone Meal	1,600
5	Cotton Seed Meal	800
	Sulphate Potash, low grade	400
	Acid Phosphate	600
6	Cotton Seed Meal	800
	Acid Phosphate	600
7	Cotton Seed Meal	800
	Muriate Potash	200
8	Cotton Seed Meal	160
	Muriate Potash	160
	Bone Meal	1,600
9	Cotton Seed Meal	800
	Muriate Potash	160
	Acid Phosphate	600
10	Cotton Seed Meal	800
	Kainit	800
11	Cotton Seed Meal	160
	Bone Meal	1,600
	Kainit	800
12	Cotton Seed Meal	800
	Kainit	800
	Acid Phosphate	600
13	Cotton Seed Meal	800
	Pot., Mag., Carb	500
14	Cotton Seed Meal	800
	Pot., Mag., Carb	500
	Bone Meal	1,600
15	Cotton Seed Meal	800
	Pot., Mag., Carb	500
	Acid Phosphate	600
16	Cotton Seed Meal	800
	Sulphate Potash, high grade	200
17	Cotton Seed Meal	160
	Sulphate Potash, high grade	160
	Bone Meal	1,600

Plot.	Ingredients.	Lbs. per Acre.
18	Cotton Seed Meal	800
	Sulphate Potash, high grade	160
	Acid Phosphate	600
19	Am. Sulphate	200
20	Am. Sulphate	200
	Sulphate Potash, high grade	200
21	Am. Sulphate	40
	Sulphate Potash, high grade	160
	Bone Meal	1,600
22	Am. Sulphate	40
	Muriate Potash	160
	Bone Meal	1,600
23	Am. Sulphate	200
	Muriate Potash	160
	Acid Phosphate	600
24	Am. Sulphate	40
	Kainit	800
	Bone Meal	1,600
25	Am. Sulphate	200
	Kainit	800
	Acid Phosphate	600
26	Am. Sulphate	200
	Pot. Mag., Carb.	500
	Acid Phosphate	600
27	Sodium Nitrate	280
28	Sodium Nitrate	280
	Sulphate Potash, high grade	200
29	Sodium Nitrace	280
	Sulphate Potash, high grade	160
	Acid Phosphate	600
30	Sodium Nitrate	280
	Muriate Potash	160
	Acid Phosphate	600
31	Sodium Nttrate	280
	Sulphate Potash, low grade	400
	Acid Phospuate	600
32	Sodium Nitrate	280
	Kainit	800
	Acid Phosphate	600
33	Sodium Nitrate	280
	Pot., Mag., Carb	500
	Acid Phosphate	600
34	Blood and Bone	680
35	Blood and Bone	680
	Sulphate Potash, high grade	160
36	Blood and Bone	680
	Sulphate Potash, low grade	400
37	Blood and Bone	680
	Kainit	800
38	Blood and Bone	680
	Muriate Potash	160
39	Blood and Bone	680
	Pot., Mag., Carb	500
40	Cotton Seed Meal	800
	Sulphate Potash, high grade	160
	Acid Phosphate	600
	Lime, air slaked	1,000
41	Sodium Nitrate	200
	Kainit	800
	Acid Phosphate	600
	Lime, air slaked	1,000
42	Am. Sulphate	200
	Sulphate Potash, high grade	160
	Acid Phosphate	600
	Lime, air slaked	1,000
43	Blood and Bone	700
	Pot., Mag., Carb	500
	Acid Phosphate	600
	Lime, air slaked	1,000
44	Cotton Seed Meal	800
	Sulphate Potash, high grade	200
	Acid Phosphate	600
	Muck, air dried	10,000
45	Sodium, Nitrate	280
	Kainit	800
	Acid Phosphate	600
	Muck, air dried	10,000
46	Am. Sulphate	200
	Sulphate Potash, high grade	200
	Acid Phosphate	600
	Muck, air dried	10,000
47	Blood and Bone	700
	Pot., Mag., Carb	500
	Acid Phosphate	600
	Muck, air dried	10,000
48	Am. Sulphate	50
	Pot. Mag., Carb	500
	Bone Meal	1,600
	Lime, air slaked	3,000
	Muck, air dried	10,000
49	Am. Sulphate	200
	Sulphate Potash, high grade	400
	Acid Phosphate	600
50	Am. Sulphate	40
	Sulphate Potash, low grade	400
	Bone Meal	1,600
51	Am. Sulphate	40
	Sulphate Potash, low grade	400
	Acid Phosphate	600

Plots 1 to 18, 40 and 44 have cotton seed meal as a source of nitrogen. Plots 19 to 26, 42, 46, 48 to 51 have sulphate of ammonia as a source of nitrogen. Plots 27 to 33, 41 and 45 have nitrate of soda as a source of nitrogen. Blood and bone were applied to plots 34 to 39, 43 and 47. High grade sulphate of potash was applied to plots 16, 17, 18, 20, 21, 28, 29, 35, 40, 42, 44, 46 and 49. Low grade sulphate of potash was applied to plots 2, 3, 5, 31, 36, 50 and 51. Kainit was

applied to plots 10, 11, 12, 24, 25, 32, 37, 41 and 45. Muriate of potash was applied to plots 7, 8, 9, 22, 23, 30 and 38. Magnesium-potassium carbonate was applied to plots 13, 14, 15, 26, 33, 39, 43, 47 and 48. Bone meal was applied to plots 3, 4, 8, 11, 14, 17, 21, 22, 24, 48 and 50. To this should be added plots 34 to 38, 43 and 47 which were treated with blood and bone. Acid phosphate was applied to plots 5, 6, 9, 12, 15, 18, 23, 25, 26, 29, 30, 31, 32, 33, 40 to 47, 49 and 51. The endeavour has been to give to every plot represented as much ammonia as any other plot received, and the same in regard to potash and phosphoric acid. (Excepting in cases of incomplete formulae.) In comparing the above notes the reader will notice that the different forms of potash were placed as nearly contiguous as the circumstances allowed. Therefore, the conclusions reached in regard to potash in this experiment must be considered as being the most satisfactory. The appended table will give the plots in such a way that they may be compared with one another to better advantage :

	Potassium Sulphate High Grade.	Potassium Sulphate Low Grade.	Kainit.	Muriate Potash.	Potassium Magnesium Carbonate
Cotton Seed Meal and Bone Meal	17 6th Class.	3 4th Class.	12 6th Class.	8 3rd Class.	14 4th Class.
Cotton Seed Meal and Acid Phosphate	18 6th Class.	5 5th Class.	11 3rd Class	9 4th Class.	15 4th Class.
Am. Sulphate and Bone Meal	21 3rd Class.	50 2nd Class.	24 3rd Class.	22 4th Class.	48 3rd Class.
Am. Sulphate and Acid Phosphate	49 2nd Class.	51 2nd Class.	25 6th Class.	23 6th Class.	26 3rd Class.
Sodium Nitrate and Acid Phosphate	29 5th Class.	31 2nd Class.	32 4th Class.	30 5th Class.	33 5th Class.
Blood and Bone	35 1st Class.	36 1st Class,	37 1st Class.	38 1st Class.	39 1st Class.
Blood and Bone and Acid Phosphate					43, 47 2nd Class.

EXPLANATION OF THE TABLE.

The above table shows the composition of the fertilizer applied to each plot and the class to which each plot belonged in December, 1898.

The plots marked 1st class were better than what one is accustomed to find in pineapple sections. Plots marked 2nd class would pass for fine. 3rd class good. 4th class indifferent, with some spiky plants, 5th class poor, with considerable percentage of spiky plants. 6th class practically worthless, over 40 per cent. spiky and the rest doing poorly.

CONCLUSION.

Ammonia.—For young pineapple plants growing on spruce pine land which has not been fertilized before, blood and bone furnish the

best form of ammonia used. Nitrate of soda comes next to blood and bone, but there is a strong difference and a considerable step between these two. Bright cottonseed meal gave better results than sulphate of ammonia. Our experiments therefore, seem to indicate that as a source of ammonia, blood and bone stand first, nitrate of soda second, cottonseed meal third, and sulphate of ammonia fourth of the substances with which we have experimented.

Potash.—While there is a great variation in the different plots treated with different forms of potash there seems to be a greater difference due to the combination than to any particular form of potash. Summing up the whole and noting the character, we find that potassium-magnesium carbonate proved the most efficient. Low grade sulphate of potash, frequently called the double potash salts, stands second in the list. While none of its plots are unusually good, it has the good character of having very few poor plots. High-grade sulphate of potash stands slightly below low-grade sulphate of potash in the potash list. Muriate of potash stands fourth in the list when all of its combinations are considered, in spite of the fact that the best plot in the field was fertilized with muriate of potash.

Phosphoric Acid.—As a whole, the experiments indicate that a small amount of soluble phosphoric acid will suffice. Acid phosphate is decidedly an unprofitable fertilizer in nine-tenths of the combinations. Its bad effects cannot be ascribed to the presence of sulphuric acid or other caustic material. Bone meal has shown itself a very efficient substance.

No fertilizer ingredient used in the above experiments is absolutely bad in itself, but becomes bad by being combined with certain other forms. The detrimental effect of the fertilizers cannot be said to be due to some caustic substance in the combination. The facts accumulated are not sufficient to warrant any further conclusions to be drawn.

VANILLA. *

BY J. CH. SAWER, F.L.S.

(From Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry, intended to serve Growers, Manufacturers and Consumers.)

In Mexico, plantations are established either in virgin forests or in open fields. In the former case it is necessary to cut down all shrubs, climbers, and such large trees as would cause an excess of shade, leaving only young trees suitable to serve as supports to the plants. The orchid attaches itself to the bark by means of aerial roots (produced from the nodes) which are its veritable organs of nutrition; the subterranean roots being very insignificant in comparison to the size of the plant. It is not uncom-

* See also Bulletin of the Botanical Department of Jamaica, Oct. 1888.

mon to observe the gradual decay of the stalk near the root which is in the ground, and at the same time a remarkable development of the same stalk as it increases in length. Close to each tree, two cuttings are planted side by side in the following manner:—in a shallow trench about an inch and a half deep and fifteen or twenty inches long, is imbedded a cutting as far as three joints or eyes, the three leaves being first stripped off; the trench is then covered up with dried leaves, leaf-mould, coarse sand, brush-wood, &c. The bed should be slightly raised above the level of the soil in order to prevent a collection of stagnant water which might rot the plants. The remainder of the shoot, 3 or 4 feet long, is tied against the tree. The supporting trees should be quite 12 or 15 feet apart to allow sufficient room for the development of the plant, the growth being very rapid. After a month the cuttings will have taken root, and must be carefully kept free from weeds and underwood of all kinds. In the third year these plants will commence to bear fruit. Planting takes place in the rainy season ; in default of sufficient rain, the cuttings must be frequently watered. In the case when it is desirable to plant a field, plain, or low-lying ground, the method in Mexico is first to thoroughly plough up the land and sow it with maize. While this is growing, a quantity of young lactescent trees, of the fig tribe, make their appearance over the field ; these after a year or eighteen months, are large enough to support the vanilla plants, which are set in the manner above described, and from them the finest product is obtained.

The method of cultivation adopted in the island of Reunion is different ; the plant being so trained that all the flowers may be within easy reach of the hand of the cultivator, not so much for facility of gathering the fruit as for the purpose of artificially inoculating the flowers. The plantation may be started in the forest or in an open field. In the first case, the cuttings are set at the foot of trees, and the trunks are connected together transversely by sticks of wood or bamboo attached horizontally, so as to form a sort of trellis on which the plant can spread freely. In no case are the trees lopped to allow too much sun, for the plant loves a humid soil and is injured by the direct burning rays. It is under large trees that the vanilla plant is seen in its typical form, vigorous and richly productive. When an open field is selected as the site of a plantation, the necessary supports for the plant must first be grown. For this purpose mangoes and fig trees are preferred, also the *Jatropha Curcas*, the tree producing the "physic-nut" which strikes readily from cuttings, and is of rapid growth.

When these young trees have attained a size sufficient to afford the necessary shade, cuttings of the orchid are set in the following manner : Between the trees and following the lines in which they are planted, a trench 8 inches deep is dug, the cuttings are placed in it and covered with a little leaf-mould, dry leaves, and straw. The rainy season is preferred for this operation, as success in striking the cuttings depends essentially on moisture and shade. When the young shoots begin to grow, they only need to be guided and spread along the trellises previously arranged to receive them, and to allow the adventitious roots to connect with the trench between the supporting trees. In two years the plantation is in full bearing.

The following cultural instructions were contributed by David de Floris, of Reunion, to the 'Journal of the Agricultural Society of India' *:—The cuttings must have at least three knots, but may have more according to the disposition of the protecting trees, or the shade which they can give. All trees are good as protectors with the exception of those which change their bark; the best are the Mango-tree, the black-wood (*Acacia Lebbek*), the Dragon-tree (*Dracaena Draco*, or *Pterocarpus*), the Jack-tree *, the Ouatier (*Bombax Malabaricum*,) and the Pignon d'Inde or Physic nut (*Jatropha Curcas*); but this last should not be planted alone, on account of its shedding its leaves when the vanilla plants are in bearing, the sun then striking upon the vanillas and on their pods, being very injurious to both. It is necessary to plant the "Pignon d'Inde" between the Dragon-trees and the Ouatier or other trees, the leaves of which may serve to shade it as well as the vanilla plant, to which it only serves for a protection during a certain period of the year. The protecting trees ought to be planted six feet apart, in rows from east to west. They should be occasionally pruned, so as to produce a half-shade or chequered shade, and they should be sufficiently grown to produce this demi-jour before the vanillas are planted. In case, however, one should require to plant before the necessary shade exists, the plants should be surrounded with palm leaves in preference, and watered much more often than if they had their natural shade; the cutting should be planted at the side of the supporting tree opposed to the sun. The longer the cutting the more knots must be put into the ground, one knot when the cutting has three, two when has four, and four or five knots when long creepers are planted. These cuttings should be laid in the ground the tendrils towards the tree, and well fixed with one, two, or several flat ties according to their length. They should not be tied with a round string, which would eventually strangle the plants, but with a sort of bast or fibre from the leaf of the Pandanus vacoa. Manure to the cuttings would be hurtful, but rooted plants may be manured with rotted dung if the soil be poor. Vegetable manure composed of rotted leaves is preferable to dung, being less heating, but the stuff must be well rotted as the young roots are very tender and delicate. Watering in the first few days after planting is always an absolute necessity, particularly in a dry locality. Plants put in the middle of the cold season languish, lose their buds, and often perish. The earth should be trodden down on each plant after having been watered. The plantation should not be made very near the sea-shore unless protected by trees from the direct action of the salt air blowing over the plants, as such would render them poor and sickly. A ground sloping to the west is preferable, as permitting more warmth to the plants and less exposure to the wind. It is advised to manure the plants once a year, a little before the flowering-season, and to cover the manure with stones to prevent its evaporation; the stones also serving to keep the roots cool, and prevent the rains washing the earth away. Too much shade, or shade badly applied, seem almost as prejudicial to a good crop as the other extreme of exposure. Pods which have been too much shaded are long, soft, thin, and difficult to

* Vol. xi. part iv.
* Artocarpus integrifolia, L.

ripen ; whereas, on the contrary, when they are sufficiently exposed to the sun they are fat, round, firm, and contain much more flavour.

No plant should be allowed to bear too freely, the quality and size of the pods suffer thereby. The pruning out of pods should be performed after the fruit is fairly set, and should be proportioned to the age and health of the creeper ; not more than five or six pods being allowed on a single cluster. A plant of three or four years growth has hundreds of blossoms thereon, but the quantity of pods taken from the same should not be more than will yield half a pound of dried produce.

Of course in its native place of growth, the method of propagating by striking young shoots of three feet or so in length is the most rapid method ; but stock could probably be reared from seed taken from pods which have matured naturally by being left on the plant ; such pods split open and drop some of their seed.

FECUNDATION OF THE FLOWER.

In the flower of the vanilla the male organ is separated from the female organ by the light membranous skin of the labellum (the upper lip of the stigmatic orifice), thus totally covering the female organ, and as the anther rests on that valve of the stigma, it is evident that notwithstanding the dehiscence of the anther, the orifice which allows passage of the pollen is closed by the labellum, thus rendering spontaneous fecundation comparatively rare. In Guiana, Mexico, and all other countries where the plant is left to itself, it has been observed that a length of 12 to 26 inches of vine will only produce one pod, the number of flowers growing on such length of stalk being about forty, all of which can be artificially fecundated. The flowers are produced in clusters in the axils of the leaves. A plant in full health and strength may produce as many as two hundred clusters at a time, each cluster consisting of from fifteen to twenty flowers. A single plant therefore, may bear three or four thousand flowers. The flowers in a cluster expand one after the other, and only last a day. By some cultivators it is thought desirable not to fertilize more than two or three flowers in each cluster, and to select for the operation the largest and finest flowers ; these are generally to be found amongst those which are the first to open. (Other cultivators fertilize five or six flowers.) If this rule be observed, it will be found that the quality of the pods will largely compensate for the quantity which might be obtained by fertilizing a large number of flowers.

The old process of performing the operation of artificial fecundation consisted in cutting the valve which is the obstacle to the natural process, but this plan was not always successful ; and it was improved upon by a Creole slave, who discovered that a more rapid and sure way was to lift up or tear away the valve from beneath the anther, and so bring that organ in direct contact with the stigma. In this way it is possible to obtain more than 3,500 pods on a single plant, but such a demand on the plant would cause it to perish before the fruit could mature ; therefore, as before observed, it is advisable to fecundate only the finest flowers on each bunch, selecting those which present a large fleshy peduncle. It is an ascertained fact that the handsomest fruit are produced from the first flowers, but the best fruit from the last flowers

which open on each bunch. Fecundation is assured when the flower is persistent, and dries at the extremity of the fruit. This result obtained, the remainder of the bunch with all its buds should be cut off.

The flowers of the vanilla begin to appear in June, and are fecundated up to September. (In India from February to April.) The fecundation should be made from 8 to 9 o'clock in the morning till 3 in the afternoon, and the earlier the better. The operation should be done with great care, using as little force as possible.* The instrument employed is simply either a small bamboo about three inches long, cut very thin and rounded off at one end, or the dorsal rib of the leaves of palms. The operation is quite simple, and may be executed with great rapidity by a light and practised hand. An expert will fertilize as many as a thousand flowers and upwards in the course of a forenoon. The rule is as follows :—Seize the base of the flower between the thumb and middle finger of the left hand, placing the forefinger on the back of the gynostemium to support it. Or, between the fore and middle fingers of the left hand, held horizontally, place the three upper petals of the flower, raising the thumb and keeping it close to the anther. Now, with the little instrument held in the right hand, tear the piece of the corolla resembling a hood, in order to expose the organs of fecundation. The end of the instrument is then introduced under the upper valve of the female organ. When this valve is completely raised straight up, the stamen, which at first rises with it, tends to return to its original position, bending towards the female organ ; this inclination must now be assisted with the thumb of the left hand, lightly pressing the stamen against the stigma, to which it will adhere. Nothing now remains to be done but gently to withdraw the instrument, and the flower is fertilized. If, at the end of the third day, the flower which begins to wither immediately after the operation, maintains its position on the summit of the ovary, the operation has been successful.

HARVESTING THE FRUIT.

The fecundated flower decays and dries at the extremity of the ovary, and after a few days falls off, leaving the persistent gynostem attached to the fruit, which continues to grow for a month, but must be left on the stem for six months longer to allow it to ripen completely. The first pods to ripen are generally inferior to those which mature later. It is most important that pods should not be gathered before they arrive at the proper stage of ripeness, otherwise they ferment and rot in a few months after preparation. The end of the pod begins to turn yellow when it is approaching ripeness, but the only certain indication of maturity is the crackling sound produced when the pod is pinched between the fingers. It is quite as important to avoid gathering the fruit too late as too early ; if over ripe it is apt to split on the stalk ; and if not so found, it will split in the curing. It is advisable to visit the plantation frequently when the time for ripening approaches and pluck the pods from day to day as they reach the required degree of maturity, and not detach the entire bunch as is done in some countries.

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* For drawing of flower and its parts, see Bulletin, Oct., 1888.

Some precaution is required in separating the pods from the stem. The fruit should be grasped with the right haad towards the butt-end, and removed from the stem by a gentle twist from right to left. Some persons take the pod by the middle or by the end and draw it roughly towards them ; when so treated it often breaks, or the entire bunch is detached from the tree with the pods still unripe. Other persons gather it by pinching it off with the nails, but then the but-end no longer existing prevents uniformity in the packets and raises difficulties for the sale.

CURING THE FRUIT.

The odour of vanilla does not exist in the fruit as it is gathered, but is developed by a process of fermentation in the curing. When a pod is allowed to fully ripen on the plant it splits into two unequal parts, becoming first yellow, then brown, and finally black. While it is drying it exudes an unctuous liquid of a dark red colour, called *balsam of vanilla* and when quite dry the pod becomes brittle and devoid of all perfume.

The following are the various processes for curing vanilla and preparing it for the market :—

Guiana process.—The beans are placed in ashes, and there left till they begin to shrivel ; they are then wiped, rubbed over with olive oil, and their lower end having been tied they are left to dry in the open air.

Peruvian process.—The beans are dipped into boiling water, tied at the end, and hung in the open air. After drying twenty days they are lightly smeared over with castor oil, and a few days afterwards tied up into bundles.

Mexican process.—As soon as gathered the beans are placed in heaps under a shed protecting them from sun and rain, and in a few days when they begin to shrivel, are submitted to the "sweating" process ; this is carried on in two different ways according to the state of the weather. If it happens to be warm and fine the beans are spread out in the early morning on a woollen blanket and exposed to the direct rays of the sun. At about midday, or one in the afternoon, the blanket is folded around them and the bundle is left in the sun for the remainder of the day. In the evening all the vanilla is closed in air-tight boxes so that it may sweat the whole night. The next day the beans are again exposed to the direct action of the sun ; they then acquire a dark coffee-colour, the shade being a deeper brown in proportion to the success of the sweating operation. Should the weather be cloudy, the vanilla is made into bundles, and a number of these are packed together in a small bale, which is first wrapped in a woollen cloth, then in a coating of banana leaves, and finally the whole is enclosed in a thick matting and sprinkled with water. The bales containing the largest beans are now placed in an oven heated to 60 ° C. (140 ° F.). When the temperature of the oven has fallen to 45 ° C. (113 ° F.) the smaller beans are introduced, and the oven closed tightly. Twenty-four hours afterwards the smaller beans are taken out, and twelve hours later the larger ones. During this process the vanilla has sweated and acquired

a fine chestnut colour. The delicate operation of drying has now to be commenced ; the beans are spread on matting and exposed every day to the sun during nearly two months ; when the drying is nearly complete sun-heat is no longer needed, and the beans are spread out in a dry place until the necessary degree of desiccation is arrived at. Finally they are tied in small bundles for the market.

Réunion process.—The beans are sorted according to length before being subjected to the treatment. The long ones are steeped in water at 90° C. (194° F.) during ten seconds, the medium size during fifteen seconds, and the short ones fully a minute. They are then exposed to the sun between woollen blankets daily until two or three o'clock in the afternoon until they acquire the characteristic chestnut colour. After this exposure, which may last from six to eight days, the beans are spread out under sheds to dry gradually. The sheds in this colony being roofed with zinc, they really constitute drying-closets, through which a current of hot air continually circulates. This desiccation takes about a month, during which time the only care necessary is to turn the beans frequently, so that they dry evenly. At the moment when it is found that the beans may be twisted easily round the finger without cracking—that is to say, when they have acquired a degree of dryness which can be judged only by experience, a fresh operation is commenced which requires the most minute and vigilant care ; this is termed the smoothing process. The operator must pass every bean between his fingers repeatedly, for, on drying, the beans exude from their entire surface a natural fatty oil. It is to this oil, which exudes as the fermentation proceeds, that the lustre and suppleness of the beam is due. When the beans are sufficiently dried they are tied into bundles, each of them being composed of fifty pods of uniform length. In this manner three commercial sorts are obtained, and termed as follows:—1. " Fine vanilla." 8 to 11 inches long, very dark brown or nearly black, unctuous glossy and clean-looking, and finely furrowed in a longitudinal direction. These soon become covered with an abundance of the frost-like efflorescent crystals technically called " givre;" 2. " Woody vanilla" 6 to 8 inches long, lighter in colour, more or less spotted with grey, not glossy. These are generally the produce of pods gathered in an unripe state. They frost or " givre" very little, if at all; 3, " Vanillons" of which there are two sorts, those obtained from short but ripe fruit, which are excellent and frost well, and those from abortive and unripe fruit, whose perfume is simply the result of absorption from the fine beans with which they have so long been in contact.

There are modifications of these processes, but they do not materially differ. Of course under different climatic conditions different modes of curing are adopted, but the sweating or fermentation must be effected by one means or another.

The finished product being sorted and tied up into bundles according to the length of the pods, is finally packed into tin boxes of different dimentions according to the length of the bundles; each box containing 10 to 12 kilogrammes ; no paper or wrapper whatever being enclosed, as such might be injurious to the preservation of the pods. The boxes are soldered up and labeled according to the quality of the contents.

THE PARASITIC ENEMIES OF CULTIVATED PLANTS.*

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A study of nature leads us to believe that since the very dawn of life on the earth a constant warfare has been going on between living beings of every kind. Out of this carnage and strife have arisen the almost endless forms of life we see about us on every side at the present day. The struggle is not by any means ended, nor is it being fought to-day on any radically different lines from what it was in the ages gone by. Plants growing in our meadows, woods, and pastures at the present time are being destroyed by innumerable animal and vegetable foes, while these in turn are disappearing before the relentless attacks of their enemies much as they did in the days of the ancients. That man plays an important part in this struggle, and that the outcome in many cases deeply concerns him, goes without saying. It is often a question of vital importance to him whether he can turn the battle in his favour, or, if he is the intended victim, whether he can find a means of coping successfully with his enemy.

It is of these questions we propose to speak, in the hope that what is said will lead to a better understanding of what science is doing for agriculture, horticulture, and kindred industries upon which so much of the nation's wealth and prosperity depends.

This brings us properly to the subject of this paper, i.e., the modern methods adopted by man in fighting the enemies of cultivated plants. Before taking up the question directly, however, it would perhaps be well to say something about the enemies of plants themselves, as a knowledge of what they are and in what manner they destroy our crops will make what is said about fighting them more intelligible. It would be entirely beyond the province of this paper to discuss all the enemies of plants or, for that matter, even a very small number of them. Our remarks, therefore, will be confined to two kinds of enemies which cause diseases in plants; but first it is important to get a clear knowedge of what constitutes a disease, after which it will be proper to consider the causes that may bring about such conditions. Taking up the first question we will say that any derangement of the vital functions of an organism, whether it be animal or plant, may be characterized as a disease.

Under this definition, which is rather a broad one we will admit, the plant may be diseased and still serve its purpose so far as its usefulness to man is concerned. Perhaps the best definition of the word for us to adopt, as we are not addressing our remarks to scientists, is that a disease is any change in the normal condition of a plant which results in a failure or partial failure to produce the usual quantity or quality of grain, fruit, foliage, flowers, or whatever the part used by or for man may be. Now, then, accepting the foregoing definition, let us consider for a moment some of the causes which may bring about the conditions

* From Chautauquan.

already noted. The principal causes of the disease of plants may be divided into two classes, namely, those due to attacks of living organisms; as, for example, insects and fungi; and those brought about by conditions in which life takes no part, as unfavourable conditions of soil and climate, peculiar atmospheric influences, and physiological changes in the plant itself which cannot be assigned to any known cause but which, nevertheless, eventually bring about death or a sickly condition rendering it worthless to man.

As we are concerned only with the parasitic enemies of plants, we may dismiss all the others with the simple statement that the injuries they occasion are comparatively insignificant. This brings us now to the point of further dividing these enemies into vegetable parasites and animal parasites. Under the former are classed the fungi, while to the latter group may be referred the insects. It is of the fungi particularly that we propose to speak. Of course there are diseases caused by vegetable and animal parasites which cannot properly be referred to either, fungi or insects, but they do not concern us here.

In these days we see, hear, and read a good deal about fungi; bute despite all this, very few people have a fair conception of what they are and in what manner they can cause the destruction of entire crops. To make these matters clear it will be necessary to devote a few words tr the place in nature occupied by these plants, for such they are, afte- which it will be proper to say something about how they live, cause dis ease and death among the higher plants, and finally die themselves. To most persons fungi are the common mushrooms and toadstools which grow in pastures, on the trunks of dead trees, and other similar places. While these are true fungi they form a comparatively small part of the great group of plants, numbering over 30,000 species. By far the majority of fungi are so small that powerful microscopes are necessary to see and study them, and for this reason, perhaps, more than any other, many erroneous ideas prevail about them and the effects they produce.

To get a better idea as to what a fungus is, especially a fungus belonging to the disease producing group, let us follow the life history of one which is perhaps familiar to all, occuring as it does on the grape which is grown everywhere in this country. The parasite under consideration is commonly known among grape-growers as "mildew," but, to use a descriptive term as well as one which will enable us to distinguish it from other members of this group, we usually speak of it as the "downy mildew of the grape."

The "downy mildew" may be found in almost any vineyard any time during the months of August and September. An examination of the leaves at this time reveals, here and there on the upper sides, pale yellow spots of various sizes and more or less circular shape. Opposite these spots, on the under side, may be seen a whitish, frost-like, downy growth which has led to the adoption of the name already mentioned. In many cases where the malady is severe the entire leaf will appear yellow and sometimes red, shriveled, and dry as if scorched by fire. This is all the eye distinguishes, so there is no wonder that so many conflicting opinions exist regarding the cause of the trouble. The microscope aided by the trained eye, however, reveals the

true state of affairs which, briefly, is that the frost-like, downy growth seen on the under side of the leaf is in reality a dense frost of exceedly delicate, colourless threads branching near the top like trees and bearing upon the tips of these branches egg-shaped bodies of the same geneeral colour and structure as the branches themselves. Further examination shows that these little tree-shaped bodies extend down into the very heart of the leaf and that they are there provided with delicate branching threads which may, for the sake of comparison, be likened to rootlets. The delicate threads are found creeping through the leaf in all directions, and, as far as they extend, the sap of the latter is destroyed. Destruction is as complete in this case as if it had been effected by heat, cold, or any other means. That the mildew is the real cause of this change in the leaf cannot be doubted.

Let us now go a little further and see what it is doing with the food for such it is, that it obtained from the vine. By means of suckers with which the minute threads already mentioned are provided, the juices which form the most vital part of the leaf are absorbed and used in building up the tree-like stems, branches, and other parts of the fungus. In other words, while the roots and green parts of the vine are actively at work obtaining materials from the soil and air out of which it is building up its own body, this insidious robber, the mildew, is stealing the material for its own benefit. If mildew were forced to go to the soil and air for its food it would die, and this is why it is called a parasite, having, as it does, to depend for its nourishment on material already prepared for it. That the mildew is a true plant has already been noted, but a closer study of it brings out this fact more strikingly. The egg-shaped bodies already mentioned as occurring on the ends of the branches borne on the under side of the leaf are in reality reproductive organs analogous to seeds. These bodies quickly fall from their attachments and being exceedingly light they are easily carried about by winds and other agents.

Whenever they come in contact with healthy vine leaves and the proper conditions of moisture and heat are present they germinate and eventually give rise to another crop of branches, root-like threads, etc., like those already mentioned. In warm, damp weather it requires only a few days to perfect a crop of the reproductive bodies, or spores, and this often accounts for the rapid spread of the disease. At the first frost the delicate exposed portions of the fungus are killed, but in the meantime another kind of reproductive body has formed inside of the leaf, where it is protected from cold. When the foliage falls in autumn these bodies fall with it and remain safely hidden away until the following spring or summer, when they are set free by the decay of the leaf. At this time it is supposed that they germinate and give rise to the frost-like patches already described. This completes the life cycle, which in all of its details is almost as complicated as that of the grape itself.

We believe now the fact that fungi are true plants has been made clear. Further, it is hoped that what has been said about the manner, in which the grape vine downy mildew lives and produces disease will, make this part of the subject understood. It is only necessary now to say a few words in regard to the number of fungi affecting plants and the extent of the injuries they occasion before taking up the

methods employed in fighting them. For many years it was known in a general way that fungi caused such disease as rusts, smut, blight, mildew, rot, etc., and were doing an immense amount of damage, but it was not until 1886 that any systematic endeavour was made in this country* to obtain information on the subject. At this time the National Government, through its Department of Agriculture, took the matter in charge. And as a result we have at the present time some reliable data on the subject. It is estimated that at the lowest figures the annual loss in this country through the agency of these foes will exceed a hundred million dollars.

The grape alone is subject to the attacks of no less than a dozen destructive fungous pests besides half a hundred which cause more or less damage. In the case of one disease affecting this fruit, i. e., black-rot, more than 50 per cent of the crop is annually destroyed in nearly all the vine-growing regions east of the Mississippi River. Grains, fruits, vegetables, and in fact nearly every plant that man cultivates, is subject to the attacks of these foes. With a view to preventing these losses the Department of Agriculture at Washington is making a scientific study of the fungi causing them. This involves first a careful investigation of the life history of each fungus in the laboratory, for it is only when we know how each lives that we can make an intelligent effort in the way of fighting it. The first thing, therefore, in our warfare against these foes is to find out where to attack them at their weakest point, and to do this requires painstaking work, often extending over a period of months and sometimes years. After we know something of the habits of a fungus we are in a position similar to that of a general who has located his foe. Plans are decided upon for the attack, which, if made at the right time and in the right place, makes victory much more certain. It must be borne in mind, however, that in conflicts of this kind man does not always come out with flying colours. Often he is utterly defeated despite the fact that he has made a hard fight, which after all makes defeat less humiliating.

In fighting the fungi two lines of attack are usually adopted, both of which, as a rule, are defensive rather than offensive. In the first method advantage is taken of the fact that at certain seasons of the year parts of the plant attacked containing the reproductive bodies of the fungus may be destroyed without injury to the plant itself. An example of this kind is found in the grape leaves affected as already described with downy mildew. It will be remembered that this fungus is carried over winter by means of reproductive bodies which are formed in late summer within the leaf, falling to the ground with the latter and escaping when the leaf decays. Now, by raking together and burning these leaves in autumn, thousands, yes, millions of these minute reproductive bodies are destroyed. Of course every one destroyed in this way lessens the chances of infection the following summer; at least such would appear to be the case from a theoretical point of view. In practice, however, it is found that work of this kind alone has very little effect, simply because it is almost impossible to get concerted action on

* The United States of America.

the part of those interested. One man may destroy the diseased leaves in his vineyard, but his neighbour may think that sort of thing a waste of time, and as a result the fungus spores that winter over in his place will be sufficient to infect all the vineyards for miles around.

The second plan of warfare consists in applying substances to the parts of the plants subject to attack that will destroy the spores of the fungus but not injure the host plant itself. This method is by far the most extensively used, as it renders every one independent of what his neighbour may do. Copper is at the present time the principal weapon used in this warfare. This poison in almost infinitesimal quantities is found to destroy quickly the reproductive bodies of some of the most destructive fungi and at the same time it is applied in such a way as to be perfectly harmless to the host plant and what is more important to man himself.

Probably no less than twenty-five different forms of copper are used for forming the basis of these fungicides, chief among which may be mentioned copper sulphate, or bluestone, copper carbonate, copper acetate, and copper phosphate. It is hardly necessary to go into the details of how these various substances are prepared, it being sufficient for our purpose to say that a great deal of experimental work has been necessary to insure a preparation that would fill the chief requirements, which are cheapness, ease of preparation and application, fungicidal efficiency, and adhesiveness. One of the fungicides admirably filling all the foregoing requirements is made by adding a whitewash or milk of lime to a solution of bluestone. Bluestone solution was tried and was found to injure the foliage badly ; moreover, the first rain removed it.

Next to fungicides the manner of applying them is the most important. It has been found that unless the various solutions are finely and evenly distributed over all parts of the plant subject to attack much of their value is lost. Machines are now made especially for this work, many of them being devised and others perfected by the Agricultural Department. The machines of this kind consist mainly of a strong force pump, a resorvoir for holding the solution, and a nozzle for making a spray. By means of the force pump, which may be worked either by a hand or horse power, the liquid is drawn from a suitable tank and forced through a rubber hose of small bore to the spraying nozzle, where it issues forth as a fine, mist-like spray. Horse power machines embodying these various parts are now made which will thoroughly spray an acre of bearing vines in 40 or 45 minutes. To get a more definite idea as to how work of this kind is carried on let us follow for a moment one who is preparing to treat his grapes for black-rot.

In the first place, thoroughly to appreciate the importance of doing everything promptly and at the right time, the man must know that the reproductive bodies or spores of the black-rot fungus live over winter in the old berries, that these escape in spring and infect the young leaves and fruit before the former are fully grown and the latter are the size of bird shot. Furthermore, he must know that the spores are present throughout the growing season every ready to infect newly exposed parts. With this knowledge in his possession, it needs no great amount of argument to convince him that to be successful he must

begin his treatments early—in advance of the fungus in fact—and repeat them often enough to keep his vines and the fruit thoroughly protected until harvest.

Assuming that our grape-grower is in possession of these facts, his first step will be to provide himself with suitable apparatus for the work in hand. If he has a small vineyard of 5 or 6 acres, a hand machine in the shape of a knapsack pump will in all probability be used. Such a machine may now be procured for a few dollars, and with it a vineyard of 5 or 6 acres can be thoroughly sprayed in a day and a half. The question of a machine being settled, the fungicide or solution to be used is the next important matter to consider. If thoroughly posted, he will be aware that of the numerous preparations used only three or four can be relied on at all times. One of these he decides upon, so there is nothing further to do but to lay in his stock of chemicals, and wait until the foliage is about half grown, or say 10 or 12 days before the vines blossom. The chemicals needed for his work are strong aqua ammonia and carbonate of copper, the latter being a fine bluish-green powder which may be obtained from almost any drug store. The proper time having arrived for making the first spraying, the chemicals, together with two or three barrels of water, the spraying machine, etc., are taken into the field. Five ounces of the carbonate of copper are then weighed out and dissolved in three pints of ammonia. This solution is poured into a barrel of water and is then ready to be applied. The pump is now brought into play, the reservoir being first filled and then taken upon the back, knapsack fashion. By means of the right hand the pump is worked bellows fashion, over the right shoulder. This forces the liquid out through the hose and nozzle on the left side. The nozzle is, therefore, placed in the left hand, and by means of it the spray is directed over the vine. The entire cost of treating an acre as here described will not exceed one dollar. About the time the berries are forming another spraying should be made and this should be repeated every twelve or fourteen days until five or six applications, costing about one dollar each, have been put on. If the work has been carefully done, comparatively few berries will rot, and this in badly infected regions means a profit of from 200 to 400 per cent. on the amount expended in the work of spraying. This is only one example of how the fight is made against foes of this kind. Of course the methed will vary somewhat with each disease. It will be seen, we believe, that the laboratory work plays an important part in every step taken in the field. It is this work that has taught us the habits of the fungus, the time to make the treatments, and the physiological effects of these on both fungus and host.

Brief reference has already been made to some of the practical results of this work. To bring out this matter more clearly, however, we will cite a few facts bearing on this subject which have accumulated within the past two years. In the past there has been a tendency to belittle the scientific work of the Department of Agriculture, especially in its bearing upon practical farming and fruit growing. It is often claimed that much of the money expended by this branch of the Government does little toward advancing the cause of the tiller of the soil. Let us then look at this matter of investigating plant diseases from a

dollars-and-cents point of view. The Department expends for work of this kind about $20,000 annually. It is known from careful and reliable data collected in 1890 that about 5,000 grape growers in this country treated their vines in accordance with the directions issued by the Department. Of these only 10 per cent. met with indifferent success. The remainder, or about 4,500, estimated the increase in their crop as a result of the treatments all the way from 15 to 80 per cent. From a money point of view this meant for some as high as $2,000, while for others the amount was as low as $10 ; the average, however, is about $50. But let us put it at the very lowest figure, say half this amount, or $25 profit for each of the 4,500 who used the remedies successfully ; this will give us a total profit of $112,500, or nearly six times the amount expended by the Department in the entire work. It must be remembered that this is for only one disease. Fully as good a showing could be made with others, such as potato rot, apple and pear scab, pear, plum, and cherry leaf-blight, etc.

A few words now in regard to the modern method of warfare against the insect enemies of plants. People as a rule are sufficiently familiar with the manner in which insects cause the loss of crops to know that in fighting them two methods may be adopted, namely prevention and cure. By prevention is meant such means as stamping out these pests before they have an opportunity of spreading ; taking advantage of their habits, and planting such crops as they are likely to destroy at times when they can do the least damage, and other similar means. The importance of work of this kind cannot be over-estimated, as is shown by a case in New England which is now attracting widespread attention. A few years ago there was introduced into Massachusetts an insect from Europe which was thought to have value as a silk producer. This insect, known as the gypsy moth, already had a bad reputation ; but despite this, it was brought over here and, notwithstanding precautions were taken to keep it within bounds, it got away and soon began to multiply rapidly, carrying destruction to vegetation of nearly all kinds wherever it went. It is probable that by prompt and energetic action the foe could easily have been wiped out in its incipiency, but it seems that matters were allowed to take their own course, so that now the pest covers a territory of at least fifty miles square. At last the people of Massachusetts have their eyes open to the serious nature of the matter, and have gone to work in earnest to wipe out the pest. Last year $50,000 was expended in the work alone and even more will be expended this season.

The curative method of dealing with these foes resolves itself into two distinct lines ; first, that of killing the pests outright, such as by hand picking, mechanical devices, applications of poisonous liquids, powders, etc. ; and, second, the introduction and encouragement of their material enemies mainly in the shape of insects themselves. Thanks to the efforts of the National as well as State Governments, the first method, and especially the application of poisons such as Paris green, London purple, etc., is in a general way now pretty well understood. In fact, it does not seem like an exaggeration to say that the money saved each year to the husbandmen of this country by work of this kind is more than enough to pay the total expense of the Department of

Agriculture and perhaps the expense of a large number of the State Experiment Stations could also be included.

As regards the natural enemies or predaceous insects, there is an immense field for the scientist, and he has not been slow to enter it. Only a short time ago it was thought that the orange industry of California, which, as every one knows, is worth millions of dollars to the state, would be totally destroyed by a little insignificant scale insect imported through carelessness from Australia. All efforts to eradicate the pest by poison and similar treatments proved fruitless, so that as a last resort an endeavour was made to bring from Australia some of its insect foes. At last one was found, and mainly through the efforts of the Department of Agriculture it was brought to California, bred, and liberated. The result has been akin to magic, for where a short time ago millions of these scale pests were sapping the life from the trees, there is scarcely one to be found to-day. The orange industry of California has been saved, and no doubt this one act justifies every cent that will be expended for economic entomology for years to come.

Thus the warfare goes on, and if this hasty glimpse of the manner in which it is conducted shall suffice to convince a few of our readers that science is not standing idly by in the matter, we shall feel that our effort has not been in vain.

NATURE KNOWLEDGE TEACHING.

On page 33 an expression of opinion has been given with reference to teaching agricultural principles in schools by means of experimental work on plants in flower pots and plots of ground as distinct from farm work.

Prof. Robert Wallace, professor of agriculture and rural economy in the University of Edinburgh, according to *Nature*, in the main agrees with this, but does not agree with the suggestion of the Agricultural Education Committee that, in connection with elementary schools, provision should be made for practical work on plots of ground attached to the schools. In an address delivered a few weeks ago on "Nature Knowledge Teaching introduced by the Scotch Code of 1899" (Edinburgh: The Darien Press), he showed that many educational authorities at home and abroad are of the opinion that farm work at school as a means for training the sons of those who are engaged in agricultural pursuits is impracticable and valueless. Such work would only be playing at farming, and would not rouse into full vigour the real working power of a boy any more than playing at shops develops a knowledge of the laws of commerce. What is wanted is individual interest and responsibility, and a knowledge of principles. The practical work which might usefully be done is stated by Prof. Wallace as follows:—(a) Laboratory work, the collection of specimens of all sorts of suitable interesting objects, to form local school museums and home collections. (b) The systematic examination of specimens by the aid of lenses and other means. (c) The growth, for experimental purposes or for ornament, of a great variety of seeds, and of a select number of plants from

bulbs, roots, and cuttings in flower-pots, which, on a scale suitable for the local circumstances, could be duplicated at home by individual pupils, by the pupils from one household, and even by groups of pupils who live contiguous to each other—it being so arranged that each member of the combination should have a right to claim the necessary attention to one or more pots as exclusively his or her own, while the lessons to be learned from all the pots would be common to every one. (d) Field demonstrations, in which the objects of interest would be, so to say, infinite in variety. (e) And for the benefit of older children and those who have left school, as well as the more enlightened of their parents, school libraries of useful books on rural subjects, which every one could not be expected to possess.

RICE CULTURE IN THE UNITED STATES.

By S. A. Knapp. *

[Note by F. V. Coville, *Botanist.* In the year 1898 the United States used 190,285,315 pounds of imported rice, in addition to the home-grown crop of 116,401,760 pounds. Of the common cereals, barley, maize, oats, rye, and wheat, the United States produced during the same period, in addition to the domestic consumption, an export quantity of 24,205,469,356 pounds. In the case of one cereal, rice, we produce only about half the amount we consume. Of all the others we produce an enormous surplus for export. This anomalous condition is due to the fact that rice, in addition to its tropical or subtropical character, is a crop grown chiefly on wet lands, where it has hitherto been impossible to use harvesting machinery. The crop must therefore be cut with a sickle, and American hand labour has been thrown into competition with the cheap labour of the tropics,a competition that has not proved profitable to the American. Under dry-land cultivation rice is a precarious crop. From all these circumstances rice cultivation in the United States has not attained in past years the full development of a prosperous industry.

In 1880 a peculiar prairie region extending along the coast of south-western Louisiana was opened up by the construction of a railroad. In 1884 enterprising settlers began the development of a new system of rice culture, by which as now perfected, the elevated and normally or periodically dry prairie lands are flooded by a system of pumps, canals, and levees, and when the rice is about to mature the water is drained off, leaving the land dry enough for the use of reaping machines. Under this system the cost of harvesting, and therefore the total cost of production, have been greatly reduced and the industry has undergone a rapid development. In 1896 the depressing effects of a new difficulty began to be heavily felt. The varieties of rice most productive and otherwise satisfactory from a cultural standpoint under the new system were defective commercially, because the percentage of

* Bulletin No. 22. U. S. Department of Agriculture, Division of Botany.

grains broken in the process of milling or preparing the grain for market was very large, and the proportion of "head rice," made up of unbroken grains, was low. The difference in wholesale price between head rice and broken rice is about 2 cents. per pound. When the broken rice ran up to 40, 60, or even 90 per cent., and in the face of a close market, the whole industry was menaced.

On the 1st of July, 1898, an appropriation for the introduction of valuable seeds and plants from foreign countries, asked for by the Secretary of Agriculture in his estimates of the preceding year, became available, and on September 1, 1898, Dr. S. A. Knapp, of Louisiana, was appointed by the Secretary as an agricultural explorer, with instructions to visit Japan, investigate the rices of that country, and purchase a stock suited to meet the requirements of the American problem. Dr. Knapp returned in the early spring of 1899 with ten tons of Kiushu rice, which was distributed to experimenters in southwestern Louisiana and elsewhere in the rice belt. The result of the milling tests are now awaited. If the high milling quality of the Kiushu rice is maintained under our cultural conditions, the last apparent obstacle to the complete success of an American system of rice cultivation will be removed.

The accompanying report by Dr. Knapp, been prepared for the purpose of diffusing information on the new American system of rice culture and its relation to the general question of rice production.]

INTRODUCTORY.

Rice forms the principal food of one-half the population of the earth. It is never the exclusive food of a people except under necessity for short periods, but it has just claims to a wider and more general use as a food material than any other cereal.

Where dense populations are dependent for food upon an annual crop and any considerable diminution in the supply would result in starvation for many, rice has been selected as the staple food wherever the climate permits its cultivation. Among dense populations certainty of supply is of first importance.

The luxuriant growth of leguminous plants at all seasons in tropical climates provides the necessary nitrogenous food elements. Nitrogenous foods are more economically provided in this way than in the form of meats as used by the European races.

A combination of rice and pulses is a much cheaper complete food than wheat and meat, and forms a food ration which may be produced on a smaller tilled area. The individual workers in densely populated agricultural countries are forced to depend on the cheapest suitable rations ; hence, the popular dependence on rice and legumes in such closely-settled lands as Japan, China, and India.

VARIETIES OF RICE.

There is an immense number of varieties of cultivated rice, differing in length of the season required for maturing, and in character, yield, and quality. Their divergence not only extends to size, shape, and colour of the grain, but to the relative proportion of food constituents and the consequent flavour. South Carolina and Japan rices are rich in

fats, and hence are ranked in flavour and nutrition among rice-eating nations as much above Patna, which is very poor in fats, as well-fattened beef is esteemed superior to the lean animals of the range. A botanical catalogue enumerates 161 varieties found in Ceylon alone, while in Japan, China, and India, where its cultivation has gone on for centuries, and where great care is usually taken in the improvement of the crop by the selection of seed, no less than 1,400 varieties are said to exist.

PROSPECTS FOR EXTENSION OF RICE INDUSTRY.

The outlook for the further extension of the industry is very promising. There has been recently quite an awakening among the farmers to the importance of this industry, so that there have been large annual increases in the area planted. There is no satisfactory reason why the United States should not grow and mill all of its own rice, nor is there any reason why the United States should not become an exporter.

The Gold Seed South Carolina rice sells for as much as any rice in the markets. The ordinary lowland rices are much better in quality than the ordinary (non-irrigated) upland rices, provided they are grown on soils which can be drained, but there is a great difference in different varieties, especially in the hardness of the grain. The most desirable rice from the standpoint of the grower is one which will produce the largest amount of "head rice," that is, unbroken grains. Upland rices, or lowland rices of poor quality, break up during the process of milling, so that the percentage of head rice often averages only 40, or 30, or sometimes even as low as 10 per cent of the entire crop. The Japanese rices average better than the American as far as their milling qualities are concerned, and for this reason it is desirable that Japanese rices be more extensively introduced into this country, provided they maintain here the same characteristics as in their native country. The Department of Agriculture has recently imported a small amount (about 10 tons) of high-grade rice from Japan.

There is the further consideration that, as will be explained below, the adoption of the use of machinery in the rice fields similar to that used in the great wheat fields of California and the Dakotas is resulting in a revolution in methods of cultivation, greatly reducing the cost. The American rice grower, employing higher-priced labour than any other rice grower of the world, will ultimately be able to market his crop at the least cost and the greatest profit. If, in addition, the same relative improvement can be secured in the rice itself; if varieties which yield 80 to 90 per cent of head rice in the finished product can be successfully introduced, American rice growers will be able to command the highest prices for their product in the markets of the world.

METHODS OF RICE CULTIVATION IN THE UNITED STATES.

The different rice-growing sections of the South use different methods of irrigation, seeding, cultivation, harvesting, and curing. A comprehensive report on the general subject of rice cultivation may be best made by treating each of these sections or regions separately, thus emphasizing points of difference or similarity.

SOUTH CAROLINA AND GEORGIA.

The pre-eminence in rice cultivation in the United States which South Carolina has enjoyed for two hundred years has been won by careful attention to the selection of seed and by thorough cultivation.

EFFECT OF CIVIL WAR ON RICE INDUSTRY.

Rice culture in South Carolina and Georgia had so developed through a long series of years that delta lands, improved and ready for rice cultivation, were worth, prior to 1860, from $200 to $300 per acre, and were considered among the most profitable investments for capital. From 1861 to 1866 most of these lands were uncultivated and in many instances the improvements were destroyed. This, with the high price of labour since 1866, has reduced the value of the lands to less than the cost of improvements; in some cases to $25 or $30 per acre. Prominent planters, in speaking of the condition of the rice industry at the close of the war, describe the situation in the following terms :

> The industry had been remanded to its infancy. The planters had returned to their estates to find buildings, machinery, and implements destroyed; the appliances of a wonderful system of irrigation and drainage mutilated or wrecked; the long-abandoned fields grown up in tangled wilds of brush, vines, and trees; the once disciplined and supremely efficient labour of the country turned into a mob. It should be no marvel that the great majority of the planters recoiled from an industry which seemed only a desperate adventure. A few who undertook the work of recuperation succeeded at the risk of the little capital or credit left to them and often at the peril of life itself. Many failed ; none so wretchedly as those who were unfamiliar with a culture demanding peculiar experience and skill, or who were unable to adapt themselves successfully to the new régime of labour and to the unexpected character of employees who had yet to learn the severe lesson of quickly earned and untried liberty. In short, relegated to its earliest historical conditions, the rice industry of the South was practically commenced anew, and, if it had any encouragement at all, it was in the protection afforded by the import tax on foreign rice. The crops were cultivated for many years at extraordinary cost and great hazard. The embarrassments were diminished in process of time, and meanwhile, as labour became more efficient and less costly and the consumption of rice increased, so the area of cultivation and production expanded.

VARIETIES GROWN.

The gold-seed rice, justly famous for the quality and large yield of the grain, stands, in the estimation of the market, among the first rices in the world. Along the Atlantic coast it has practically superseded the white rice introduced and generally cultivated in the earlier periods of the industry. The two varieties of gold-seed appear to differ little except that one variety has a slightly larger grain than the other. White rice is valued for its early maturity. The accompanying table illustrates the difference between the grains of gold-seed rice and white rice :

	Length of the grain.	Circumfer. ence around shorter axis.	Number of grains in one Troy once.
	Inches.	*Inches.*	
Gold seed, long grain	0.417	0.375	841
Gold seed, short grain	0.375	0.375	896
White rice	0.375	0.374	960

DELTA LANDS.

A large proportion of the rice grown in South Carolina and Georgia is produced on tidal deltas. A body of land along some river and sufficiently remote from the sea to be free from salt water is selected with reference to the possibility of flooding it from the river at high tide and of draining it at low tide.

Canals and levees.—A canal is excavated on the outer rim of this tract, completely inclosing the field. The excavated dirt is thrown upon the outer bank. The canal must be of sufficient capacity for irrigation and drainage, and must also furnish dirt to make a levee which will provide perfect protection against the encroachments of the river at all seasons. The tract is then cut up by smaller canals into fields of 10 to 12 acres, making small levees on the border of each field. The fields are subdivided by ditches into strips 20 or 30 feet wide for cultivation. The entire tract is usually nearly level, but if there should be any inequality care must be taken that the surface of each subfield be level. The main canal is 10 to 30 feet wide and about 4 feet deep, and connects with the river by flood gates. Through these canals boats of considerable tonnage have ready access to the entire circuit of the tract, while smaller boats can pass along the subcanals to the several fields. The subcanals are usually from 6 to 10 feet in width and should be nearly as deep as the main canal.

Drainage.—Perfect drainage is one of the most important considerations in rice farming, because upon it depends the proper condition of the soil for planting. It may appear unimportant that a water plant like rice should have aerated and finely pulverized soil for the seed bed, but such is the case. Thorough cultivation seems to be as beneficial to rice as to wheat. Complete and rapid drainage at harvest always insures the saving of the crop under the best conditions and reduces the expense of the harvest. On 500 acres of such land, well prepared, there should be 65 to 80 miles of ditches, canals, and embankment.

If there are logs, stumps, or stones in the field they must be removed. When practicable the rice lands are flooded from the river and find drainage by a canal or subsidiary stream that enters the river at a lower level. The embankment must be sufficient to protect the rice against either freshets or salt water. Freshets are injurious to growing rice, not only because of the volume of water but by reason of the temperature. A great body of water descending rapidly from the mountains to the sea is several degrees colder than water under the ordinary flow. Any large amount of this cold water admitted to the field, not only retards the growth but is a positive injury to the crop. In periods of continued drought the salt water of the sea frequently ascends the

river a considerable distance. Slightly brackish water is not injurious to rice, but salt water is destructive.

INLAND MARSHES.

Some excellent marshes are found in South Carolina and Georgia upon what may relatively be termed high land. These are in most cases easily drained and in many instances can be irrigated from some convenient stream. The objection planters have found to such tracts is that the water supply is unreliable and not uniform in temperature. In cases of drought the supply may be insufficient; in case of freshets the water is too cold. To obviate these objections reservoirs are sometimes constructed, but are expensive, owing to loss by the evaporation from such a large exposed surface. However, where all the conditions are favourable, it costs less to improve these upland marshes than the delta lands and the results are fairly remunerative.

CULTIVATION.

During the flooding period the ditches and canals become more or less filled by the mud which flows into them with the water. As soon after harvest as possible the ditch banks are cleared of foul grasses, weeds, or brush, and the ditches are cleaned. The levees are examined to see if they are in repair. Early in the winter the fields are ploughed or dug over with a heavy hoe. At this time the ploughing is shallow, about 4 inches deep. The field is then barely covered with water, which later is drained off. Upon this saturated soil the frost acts with considerable force, disintegrating it and pulverizing the lumps. In March the land is allowed to dry, all the drains being placed in repair and kept open. Seeding commences in April and continues nearly to the middle of May. Just prior to seeding the land is thoroughly harrowed, all clods pulverized and the surface smoothed. Trenches 12 inches apart and 2 to 3 inches deep are made with 4-inch trenching hoes at right angles to the drains, and the seed is dropped in these at the rate of 114 to 135 pounds to the acre. Great attention is paid to the selection of good seed. This is usually covered, but occasionally a planter, to save labour, stirs the seed in clayed water, enough clay adhering to the kernels to prevent their floating away when the water is admitted. Under the usual method the water is let on as soon as the seed is covered, and remains on four to six days, till the grain is well sprouted. It is then withdrawn. As soon as the blade is up a few inches the water is sometimes put on for a few days and again withdrawn. The first water is locally called the "sprout water." After the rice has two leaves the so-called "stretch water" or "long point flow" is put on. At first it is allowed to be deep enough to cover the rice completely—generally from 10 to 12 inches—then it is gradually drawn down to about 6 inches, where it is held twenty to thirty days. It is then withdrawn and the field allowed to dry. When the field is sufficiently dry the rice is hoed thoroughly, all grass and "volunteer" rice being carefully removed. After hoeing it remains without irrigation until jointing commences, when it is slightly hoed, care being used to prevent injury to the plant, and the water is then turned on to the field. During the time water is held on the rice it is changed at least

every week to avoid its becoming stagnant. When this occurs rice is liable to be troubled with the water weevil. This "lay-by flow," or final irrigation, continues until about eight days before the harvest, when the water is drawn off for the field to dry.

Farmers differ considerably in their methods ; some hoe more than twice and some flood more than three times, and some less ; also in the final flooding the practices differ as to the depth of water maintained ; some farmers consider it advantageous to keep the water nearly as deep as the rice stem is tall till shortly before harvest and then gradually withdraw the water as the straw stiffens ; others prefer only sufficient water to properly mature the crop. The Hon. John Screven, of Savannah, Ga., an eminent authority on rice, states that irrigation along the northern rivers of South Carolina and even as far south as Charleston differs from that pursued around Savannah in Georgia, owing to the fact that the former lands are generally low and can be ploughed or flooded at any time, which is not usually the case with the Georgia land. The time the water is held on the field in the "long point flow," he claims, should depend upon the condition of the crop, and every planter must decide that for himself. He must observe the plant and allow it to acquire proper root support before making any radical change. In regard to the "harvest water," he says :

> On the start the depth should correspond to the "long point water" and should be increased with the growth of the plant, but should never rise above the collar of the leaf. This flow should be put on when, on clearing the base of the stalk of the plant, an open joint is shown. This is the initial of the grain formation and should be aided by the water.

YIELD AND VALUE OF PRODUCT PER ACRE.

Good delta lands are estimated to yield, under intelligent management, from 30 to 45 bushels to the acre. The standard weight of rough rice in commerce is 45 pounds to the bushel. In a report made by planters to the Savannah Rice Association, January 28, 1882, the average yield to the acre is placed at 30 bushels, and the annual cost of cultivation, including interest on the land, at $35 per acre. In a report made by prominent rice planters to the House Committee on Ways and Means in January, 1897, the average yield to the acre is placed at 32 bushels, and the cost of production is fixed at $24. If we take the latter estimate the cost to the planter in the Atlantic States of raising 100 pounds of rough rice is $1.66, or $2.69 per pack of 162 pounds. Of course this is only an average, the cost being much less in some instances and in others much greater.

NORTH CAROLINA, FLORIDA, AND MISSISSIPPI.

Considerable rice is produced in these States, but as the methods are similar to those practiced in South Carolina and Georgia it is unnecessary to describe them here. In these States there are quite large tracts which could profitably be devoted to rice and which are almost useless for other purposes. With the denser population of ensuing years these now ensuing waste lands will be improved and become valuable accessories to their wealth. In many sections of Florida a little capital judiciously invested in the improvement of rice lands would

bring profitable returns. In southern Mississippi there are large tracts that could be purchased at nominal figures and devoted to rice.

EASTERN LOUISIANA.

For many years small fields of rice were planted in this State to add to the food supply, but commercially rice was scarcely considered by the planters until 1865, when they were confronted by the problem of how to utilize large and desolated sugar plantations without available resources. What was at first planted for a food supply proved to be a profitable crop and the rice industry made rapid strides. In 1864 the total rice crop of Louisiana was 1,580,790 pounds; in 1866 it was 4,706,720 pounds; in 1868, 9,509,910 pounds; in 1874, 22,338,980 pounds; and in 1877, 41,630,000 pounds. At first plantations were leased, in many instances, and planted a few years while they produced a maximum crop, when they were abandoned for other lands which had not hitherto been planted in rice. This change of lands was due to the rapid increase of harmful grasses, many of which were conveyed to the fields by the irrigating water, and appeared to find such congenial conditions for growth that in about three years they were practically in full possession. In a short time it became evident that the practical supply of plantations for such purposes was limited, and that the planters must learn both to keep their fields clean from grass and maintain their fertility.

RICE GROWING ON THE LOW LANDS.

The following letter from Hon. John Dymond, a prominent planter, and for many years president of the Louisiana State Agricultural Society, gives a succinct statement of the low-land cultivation south of New Orleans:

System of levees.—Rice on the Mississippi River has generally been raised on old sugar plantations, where the ditches run down the line of descent of the land, which was excellent so far as the drainage was concerned, but the ditch banks were of no service in flooding the lands. (Along the Mississippi River the banks are highest next the stream and generally descend toward the drainage in the rear.) For flooding the lands the so-called check levees were thrown across the line of fall of the land sufficiently near to each other so that any small levee not exceeding 2 feet in height could hold back water enough to reach up the incline until another check levee intervened. Where the lands had but little fall but few check levees were necessary, and where the fall was great there had to be many of them. I should say that ordinarily a check levee was required every 400 feet. As the sugar plantation ditches were hardly ever more than 200 feet apart and the check levees but from 200 to 400 feet apart, the result was very small fields of from 1 to 2 acres, in which machines could not be worked to advantage. Therefore the harvesting machines have never been used with much success on the river.

These check levees cross the old ditches with either plank or earthen dams, and the size of the plats of the land would vary from 1 to 2 acres up to 10 to 20 acres, if the water could be held on such a large space. I should say, however, that fields of this size were very rare in the river rice districts, little fields of 5 to 10 acres being far more numerous.

Flooding.—On the lower coast the fields are flooded before any work is done; they are ploughed in the water; the rice is then sowed upon the fields and harrowed in the wet. The water is then taken off and the rice germinates at once. It has to be nursed very carefully with water for fear the

young rice may be scalded by the hot sun, the planting not being done until late in April or in May. In what is generally known as dry culture the land is prepared as for oats and carefully harrowed. The rice is then planted broadcast or with drills—generally broadcast—and when it comes up, or rather after it comes up, the lands are moistened with water and the water kept a little below the tops of the plants, following them up as they grow taller. The water is not taken off these plants unless, as is commonly thought, they are attacked by crayfish. This, however, is regarded by many as doubtful. Sometimes an increased quantity is put upon the lands for the purpose of covering the plants so as to drown the caterpillars that attack them at this stage of growth. Flooding the land several times, as is practiced in South Carolina, is not known here. If no mishap occurs to the crop the water is kept upon it constantly from the time it comes above the ground until the lands are drained off preparatory to harvesting.

Preparing land and sowing seed.—For dry culture, the lands are ploughed in winter. For wet culture the lands are only ploughed about the time of planting—say, in April. In dry culture it is considered good practice to sow late in March, and reasonably good practice to sow in April. In wet culture it is expedient to sow before the latter part of April. Rice planted up to the 15th of May is considered good for a fair yield; planted after that the yield will be cut down in quantity. If planted late in June it matures so late in the fall that the cold nights are apt to shrivel it and but a small crop will be realized. On the river the rice is generally sown by hand. Broadcast seeding machines have been used, but not to any extent. Some rice has been planted with drills, but they never obtained much use among the river planters.

Harvesting and thrashing.—The rice is cut when it matures, generally in August, and is put in shocks of about 20 bundles each. It ordinarily remains in these shocks about a week, during which time the shock dries out some and may heat a little. The old rice planters think it wise to then carry the rice into a yard called a battery, and to stack it there carefully, where it undergoes some sweating, during which it is liable to stack burn. Most of our river planters, however, now prefer to cut the rice, to tie it up, to ship it off after a few days only, and to haul directly from the shocks to the thrashing machine, the rice lying sufficiently long on the stubble to dry it before it is tied up, and very little curing is then required in the shocks. Practically all of the rice is thrashed at once; whereas, if stacked, it sometimes burns if left too damp. Under my own observation there has been produced on this land as high as 30 barrels (4,860 pounds) of rough rice per acre. This was upon good land that had been in peas and had been fall-ploughed with six mule teams. The average product per acre on the lower coast (Mississippi River) will not exceed 8 barrels, and 12 barrels is considered a good crop.

Wet culture and weeds.—I think the same general rules will apply to the upper coast, but usually on the upper coast they resort to dry culture, while the lowness of our rice lands on the lower coast leads to a great deal of ploughing actually in the water. Again, our people plough in the water, because what are called our best rice lands are buckshot clay, and they are so stiff that the average small rice planter can not plough them with any team that he has, unless he softens them up in this way. Wet culture is a very delicate process and unless done just right is apt to end disastrously, whereas with dry culture the rice crop will come up as certainly as an oat crop, with the danger, however, of a large growth of grass coming along with it. Our planters become very skillful with their wet culture, and always strive to get rice up ahead of the grasses and weeds that have to be picked out by hand. For this reason I have always thought that the rice lands in the western part of the State were bound to supply the whole consumption of the country, owing to the facts that they could be readily drained, that our lowland weeds do not prevail there, and that the culture was rendered incomparably cheaper by the use of harvesting machines.

RICE GROWING AND WELL-DRAINED ALLUVIAL LANDS.

On the well-drained alluvial lands above New Orleans, the fields are ditched and leveed as described in the foregoing account of the lower coast rice growing. Particular attention is given to thorough drainage in February, and by the first of March the land should be ready for the plough. The land should be well ploughed and harrowed. Some advocate shallow ploughing and some claim that deep ploughing is better. Conditions vary so widely that no absolute rule will apply, but where the water supply is ample a depth of six inches will be found fairly satisfactory. Sowing is generally done broadcast and by hand, at the rate of 50 to 80 pounds to the acre, and followed by a thorough harrowing of the land. Sowing generally commences about the 20th of March, and is completed by the middle of April, the object being to place the rice upon the market as early as possible, before the price is affected by the foreign crop or that of southwestern Louisiana and Texas.

Sowing the seed.—Three different methods of treating the seed are followed. Some let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This insures the germination of the seed. Others sow and trust to there being sufficient moisture in the land to germinate the seed. This is sometimes uncertain, and rarely produces the best results. A few sprout the seed before planting by placing bags of rice in water. This is sure to be a failure if the soil is very dry when the seed is sown. In case of planting in dry soil, without following with water saturation, rolling the land after seeding and harrowing has been found beneficial.

Flooding.—When the young rice is 5 or 6 inches high, water is generally let on the field, care being exercised that it should not entirely cover the plants, and the field is kept continuously submerged until the crop matures. Where the soil is sufficiently moist to promote growth, some of the planters do not turn on the water until the rice is 10 inches high. It is claimed by them that there is great danger of sun-scalding if water is allowed on the field when the rice is very young and tender. As soon as the rice stalks indicate any change in colour at the bottom, the water is turned off.

Harvesting.—Formerly the rice was cut, allowed to dry one day, and then bound and placed in small shocks for further curing. It usually remained in the shock a week, and was then stacked. The stack was round, not more than 6 or 8 feet in diameter, and built upon a plank base about 2 feet from the ground. Recently many planters pursue the methods of cutting, curing, and threshing described by Mr. Dymond. It is not practicable, on this class of lands, to employ machinery in cutting the rice.

OBSTACLES ENCOUNTERED.

Expense of flooding.—The water used in flooding the alluvial lands along the Mississippi River was formerly drawn from the river by a pipe which pierced the base of the levee. These pipes were a constant menace to security from freshets. A majority of the disastrous breaks in the levees were attributable to them. Finally the law prohibited

their further use and required that the water be drawn over the levee, which considerably increased the cost of obtaining water for flooding.

Weedy grasses.—In all delta rice lands the rapid increase of injurious grasses becomes a serious question. This is intensified along the Mississippi by the large amount and wonderful variety of grass seed in the river water. The question of disposing of these grasses was fully treated by H. S. Wilkinson in a paper before the Jefferson Parish (La.) Agricultural Society. He made the following suggestions :

While the attempts to get rid of grass have only scored failures, there is no doubt that grasses can be thinned out considerably. From the varieties we have to contend with, embracing as they do seeds that geaminate from February to June, it is hardly possible, under the present methods, to destroy them entirely. The chief source of supply for these grass seeds is the suckers that shoot out from the old stalks which are cut with the rice. In fifteen days after the field is cut these suckers, which grow with wonderful rapidity, are "in seed" again.

Mowing and burning the grasses.—I have met with some success in destroying this supply by following up the harvester with a mowing machine, cutting everything down, allowing it to dry, and then burning it. To do this enough time must elapse before the mowing machine is started to allow the suckers to send out new leaves, so that when cut there will be enough straw on the ground to burn. Mowing without burning is almost useless. The fire is what does the work, destroying not only the seed but the root itself, thus effectually preventing any further suckerings. Any seeds that are left by the fire, are exposed, will germinate during the first warm wet spell, and will be destroyed by the first frost. A great objection to this plan is that it leaves the land perfectly bare, to be impoverished by the parching August and September sun, and baking it so hard that it is difficult to plough. This objection would condemn it as a practical failure, and we have yet to find out some better plan of destroying this supply of seed before we can ever hope to succeed in establishing permanent rice plantations.

Winter flooding a failure.—If these grass seeds are not destroyed in the fall, they are scattered broadcast by the wind, protected from heat and cold by the luxurious growth, and only germinate when the continuous warmth of spring, penetrating the ground, causes all vegetation to start. I thought these seeds might be destroyed in winter by keeping them under water, and, on one occasion, having a place well located for that purpose, I kept a field under water all winter, and had it ploughed in the spring. The straw, and, in fact, all vegetable matter had rotted, leaving the land perfectly clean, but a few days of exposure to the sun brought out a first-class stand of grass. The grass seeds will not rot without germinating, and they will not germinate in cold water.

The best plan of dealing with grass.—Having thus seen that, by the methods suggested, these seeds can not be destroyed without disadvantage before spring, the best plan to adopt will be to burn off as soon as possible after the grass is killed by frost ; by this means some of the seeds are destroyed by fire, some by ice, and the balance being exposed, will feel the warmth much earlier, and will germinate in time to be destroyed by ploughing, providing the ploughing is delayed long enough. This method is almost as objectionable as mowing and burning in the fall, as the ploughing is delayed till March, the planting is late, and all the benefit of the August market is lost; but it is still in my opinion the most advantageous plan. The grass seeds are in the ground, producing a hardier and more prolific plant than rice. The man who calculates that they will not come up, finds out his mistake too late to remedy it, except at considerable cost.

Hand weeding.—Hand weeding is out of the question, being too slow and expensive for the large planter. One of the great advantages of hand weed-

ing consists in pulling the grass up by the roots, which, while it effectually destroys the grass, loosens up the land, and when properly done is equivalent to a thorough working. This requires considerable sleight-of-hand and care, and is the kind of work that can not be done by inexperienced hired labour.

Rice comes nearer to being a cultivated crop in the lower part of Plaquemines Parish than in any other part of this State. It is claimed down there that rice never thrives until after it is weeded ; and we can readily see the reason, for in tearing up the grass-roots, the soil is loosened and put into condition so that the rice roots can penetrate it and secure a bountiful supply of nutriment. But this kind of cultivation is too expensive for the large planter, and his only resource, if caught with a grassy crop, is to mow everything and trust to the rapid growth of the rice to smother out its slower growing rivals. This it generally does, but its race for life absorbs all of its energies and gives it no time to sucker, thus materially reducing the yield. When our lands were new, 15 barrels per acre was about an average yield on a large place, while now we consider 10 barrels about the standard. This great falling off in a few years is not owing so to the exhaustion of the soil as to the grass crop in our rice, which chokes out the stand and prevents what is left from suckering, and to neglect of drainage in the fall and winter. As I stated before, the most successful means I have used for keeping my fields clean is to burn off early and let the grass come up before ploughing. If a clean stand can be secured,it will not be necessary to mow as a few weeds can be cut out with a cane knife. The crop can be harvested fully two weeks earlier, and a better yield obtained. While fall ploughing is advantageous in turning the land up and giving it a chance to drain, it is equally disadvantagious in covering up not only the grass seed, but the scattered rice and protecting it through winter. I have tried this repeatedly with four-horse plough, and failed in every instance to derive any benefit.

The practice of following rice with winter oats after mowing and burning the stubble and aftermath has been favourably suggested.

SOUTH WESTERN LOUISIANA AND SOUTHERN TEXAS.

It is necessary to treat of rice production in this section separately, because the methods are in some respects different from those practised in any other portion of the world.

METHODS OF RICE CULTURE REVOLUTIONISED.

The revolution in the methods of growing rice has been as great as that caused by the introduction of modern agricultural machinery into the wheat fields, which has given the United States control of the markets of the world.

In 1884 and 1885 a few farmers from the North western prairie States settled on the great southern prairie which extends along the coast from the parish of St. Mary in Louisiana to the Texas line, about 140 miles. Finding that rice, which had been grown for many years for home consumption, but by oriental methods, was well suited to the conditions of agriculture here, they commenced immediately to adopt the agricultural machinery to which they had been accustomed to the rice industry. The gang plough, disc harrow, drill, and broadcast seeder were readily adjusted, but the twine binder encountered a number of serious obstacles. However, by the close of 1886 the principal difficulties had been overcome. Wherever prairies were found sufficiently level, with an intersecting creek which could be used to flood them, they were surrounded by a small levee thrown up by a road grader or by a plough with a strong wing attached to the mould board extending it

4 or 5 feet. Very few interior ditches were made for drainage. The land was so level that fields of 40 and 80 acres were common. Large crops were produced, the prairies were practically free from injurious grasses, and the creek or river water was soft and bore no damagining seeds to the fields. The rice fields were handled like the bonanza wheat farms of Dakota, and fortunes were made. Levees were cheaply constructed; little attention was paid to drainage more than to remove the surface water; shocking, stacking and threshing were done in a very careless manner; the main object being apparently to plant a large acreage and secure a certain number of bushels, regardless of quantity. Ultimate failure was certain, but it was hastened by drought. A succession of dry years followed. The creeks failed, and reservoirs were found to be expensive and unreliable.

The soil and climatic conditions in south eastern Texas are almost precisely like those in southwestern Louisiana. Rice culture in this section requires no separate treatment. What is applicable to the one applies also to the other. There is a belt of prairie well suited to rice extending from the Sabine River west for 100 miles along the coast. Within a few years large farms have been opened and devoted to this cereal with excellent returns.

IRRIGATION.

Pumping plants.—To provide a reliable supply of water, plants for pumping were gradually substituted for the natural irrigation relied on to produce a crop on the so-called "providence rice farms." Footcnately the water in the rivers is soft, abundant, and free from silt and damaging weed seeds. The elevation of the prairies above the streams varies from 6 to 38 feet, the larger portion being from 15 to 25 feet. At first farms along the streams and lakes were irrigated; gradually large surface canals were constructed.

Canals for irrigation.—Irrigating canals were started in a small way in Acadia Parish in 1890. In 1894 a canal 40 feet wide was built for 15 miles with 10 miles of laterals. This was followed by the Crowley Canal, which is now 35 feet wide and 8 miles in length, and has 10 miles of lateral lines. The Riverside Canal was the next, and now has several miles in operation. These enterprises have grown steadily until there are now 9 canals in Acadia Parish, with an approximate length of 115 miles. There are about 25 irrigating canals in Acadia, Calcasieu, Cameron, and Veemilion parishes, with a total length of over 400 miles of mains and probably twice that extent of laterals, built at a total cost of about $1,500,000. In nearly evey township there are one or more ridges slightly above the surrounding land. On these surface canals are built from 20 to 150 feet in width, according to the area to be watered. The sides of the canal are raised from 4 to 5 feet with plows and scrapers ar with grading machinery. Grading machines work very well, as the soil is a loam or a clay loam free from stones. Side gates are inserted in the embankment as frequently as necessary. Laterals are run from the main canal. These canals, where well construeted and operated, prove entirely successful and make the rice crop a practical certainty over a large section of country. They range in irrigating capacity from 1,000 to 30,000 acres. The usual water rent charged the planter by the canal company is 324 pounds of rough rice per acre watered.

Cost of canals.—The cost of constructing permanent canals is considerable. Between the river or lake bank, at the initial point, and the general levei of the table lands, and in crossing occasional depressions the levees must be both high and wide at the base. The canal must run upou a divide in order that it may not cross any streams and may be sufficiently above the general level to water all portions of the adjacent country. The lands where the levee is to be constructed should be thoroughly ploughed before excavation is commenced ; otherwise the fresh dirt placed upon the sod does not sufficiently cement to prevent seepage.

Outlets.—The outlets for flooding the fields must be carefully protected or the crawfish will dig under the gates from the inside and eause a crevasse. A very successful plan is to bed a sill 4 by 6 inches in size across the bottom of the opening near the inner end and level with the bottom, allowing the ends of the sill to project into the bank on either side of the opening 6 feet ; then plank along the inner side of the sill the full length, using boards 3 feet long, with the top of the boards resting against and even with the sill. The boatds should stand at an angle of 45°, the lower ends being near the center of the canal. At each end of this planking a board of the same length and about 12 inches wide should be nailed at a right angle with the planking, thus projecting downward into the earth. Posts should be set against the sill at each side of the cut and at the ends, and the boarding from the sill to the top of the bank should be solid except at the outlet. A 12-inch board should be nailed at a right angle with the face of the cribbing back into the bank at the end of the sills to stop crawfish. The opening should be boarded on the sides and bottom, and this should extend 6 feet outside the cut to prevent underming from the overflow. The gate may be raised by a lever or otherwise. Openings thus constructed are paoof against damage by crawfish.

When a large number of planters are drawing their supply of water from the same canal seme will use more than is necessary and increase the expense of the general supply. Some plant very early and require water a month before the general crop is ready. These and other incidents can generally be settled with little friction.

Deep wells for irrigation.—Scarcely had the surface canals been accepted as a success when southwestern Louisiana was startled by the announcement that there were strata of gravel at 125 to 200 feet under the surface of the entire section containing an unlimited supply of water which would, of its own pressure, come so near the surface that it could be readily pumped. This was received with considerable incredulity at first, but repeated tests have proved that there is a bed of gravel nearly 50 feet in thickness underlying this section of Louisiana which carries a large amount of soft water with sufficient presiure to bring it nearly to the surface. Pipes of 2, 3, 4, 6, and 8-inch size have been sunk to the gravel and pumped continuously for months without diminution of the supply. The water is soft, at a constant temperature of about 70 degrees, and absolutely from injurious seeds or minerals. Such is the facility with which these wells are made that a 6-inch tube has been put down to the full depth required—200 feet—in fourteen hours. Thus far it has been found that a 2-inch pipe will furnish sufficient water to

flood 10 acres of rice and a 6-inch pipe will flood 80 to 90 acres. Any number of wells may be made, and even if no more than 20 or 30 feet apart one does not diminish the amount of water obtained from the other. It is probable that such wells will become common for the irrigation of other crops than rice.

Hon. S. L. Cary says :

Wells from 2 to 12 inches can be put down successfully. From 50 to 100 such wells are in successful operation in the rice belt of southwestern Louisiana Passing through alternate layers of clay and quicksand, coarse water-bearing gravel is reached at the depth of 100 to 150 feet. Forty feet of screened pipe reaching into this gravel is sufficient. A 6-inch well will furnish a constant stream for a 4 to 5 inch pump. A system of such wells may be put down 10 to 40 feet apart and each one will act independently and furnish as much water as if stood alone. Such a combinatioa of wells may be unitee just below water level and all be run by one engine and pump. Water rises materially in these wells to within 20 feet of the surface, and a number of ploughing wells have been secured. The lift is not greater than from rivers, lakes, or bayous into canals. Eight 4-inch wells united at the top can be run by one 16-inch pump and a 50-horsepower engine, and will flood 1,000 acres of rice. With present conditions there are profits to the grower. Water is the largest factor in rice production, and we are prepared to take the advice of the millionaire, "Sell water."

The total cost of an irrigating plant sufficient for flooding 200 acres is from $1,500 to $2.500. It requires about seventy days' pumping for the rice season.

DRAINAGE.

Danger from alkali.—Thorough drainage is even more essential for rice than for wheat, because irrigation brings the alkali to the service to an extent that finally becomes detrimental to the rice plant. Alkali sometimes accumulates in the soil just below the depth of the usual furrow to such an extent that any ploughing is dangerous to the crop. Experience has shown that there is but one effective way of disposing of these salts, and that is by thorough drainage and deep ploughing As the water drains away the excess of soluble salts is carried off. Now, if the ditches are no deeper than the ordinary furrow it is evident that only the surface of the soil can be declared. Until tilling can be employed the use of plenty open ditches, at least 3 feet deep for mains, must be the relief relience of the rice farmer in his fight against the accumulation of alkali in the surface sail.

Ditches.---The construction of leaves for drainage ditches is a simple process as compared with the old system of using spade and shovel. A plough with an extension moldbord, or winged scraper about 5 feet long, is generally used. Some use a plough follow by a V scraper made of plank, which removes the dirt from the furrow 4 or 5 feet to the right or to the left as the case may be, thus forming a ridge or levee. The broader ditch thus made is less liable to be choaked with grasses than ditches made with a spade or capstand ditching plough. Usually not more than 1 foot of drainage is obtained with such implements. This is ample for removing surface water, but does not give sufficient depth for thorugh drainage to put the field in the best condition for cultivation in the early spring.

HIGH-LAND VERSUS LOW-LAND RICE.

Where exclusively wet cultivation is employed, i. e., ploughing and sowing in water on lowland, the rice is considerably inferior to that produced upon soil well drained and thoroughly tilled. Rice follows the law so well establish for wheat, oats, and other cereals, that thorough cultivation not only increases the quantity produced per acre, but improves the quality and flavour of the grain. It has been claimed by some that rice, being a water plant, does no follow this rule. This is an error. The rice of commerce is an improved variety, far superior to wild rice, and the imprevement has come through better environment. We have not yet reached the limit of possible improvement in rice by this means.

The following statement by H. R. Williams, jr., of Canton, China, shows the opinion of Chinese merchants as to the relative merits of upland and low-land rice:

> Rice grown on high lands is better than that grown on low lands on about a level with the river, and brings a higher price. Furthermore, there is nutriment in the high-land rice, as the Chinese say they get as much satisfaction from a catty of high-land rice as from 1 ca¼tties of that grown on low land. All of the high-land rice is irrigated from large ponds. Rice grown upon low land is of course supplied with water from the rivers as they rise and fall. The high-land rice is a smaller grain but is harder and heavier than the low-land rice.

In Japan the cultivation of rice is more thorough, the soils are better drained during the winter than in most countries, and the product is so superior in quality and flavour that imported rices can not be sold to the Japanese in competition with their home product.

Thorough winter drainage enables the planter to plough and sow sufficiently early to harvest before the equinoctial storms and to get the benefit of the early market.

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New Hampshire. 67 (Spiny Elm Caterpillar.) 68 (Eleventh Annual Report.) 69 (Inspection of Fertilizers.) 70 (Exp. with Muskmelons.)

New Jersey. 141 (Forcing Tomatoes) 142 (Pear Growing.) 143 (The Apple Plant Louse.)

New York. 162 (Leaf Scorch of Beet, Cherry, Cauliflower and Maplet. 163 (New York Apple tree Canker.) 164 (Notes on various Plant Diseases.) 165 (Analyses of Paris Green and other Insecticides.) 166 (Commercial Feeding Stuffs in New York.) 174 (Fumigation of Nursery Stock.)

Oregon. 60 (Apple Tree Anthracnose.) 61 (Oregon Prune.)

Rhode Island. 62 (Chemical Methods of ascertaining Lime Requirements of Soils.) 63 (Feeding Stuff Inspection.)

Tennessee. 2, 3, and 4 (Grasses and Forage Plants.)

Texas. 55 (Feeding Steers.)

Utah. 64 (Codling Moth, etc.) 65 (Plant Diseases and Insect Pests. San Jose Scale)

Virginia. 99 (Growing the Apple Orchard.) 100 (Spraying the Orchard.)

West Virginia. 59 (Whole Corn Compound with Corn Meal for fattening Hogs.) 60 (Poultry Experiments.) 61 (Sheep Feeding Experiments.) 62 (Effect of Incandescent Gas-light on Plant Growth.)

Wiisonsin. 79 (Principles of Construction of Country Roads.) (Report for year ending June 30, 1899.) 80 (Character etc. of Humus Soil) 81 (Analyses of Com. Fertilizers 1900.)

Wyoming. 42 (Native Forage Plants for Alkali Soils.)

Washington. 40 (Fertilizers.) 41 (Forage Plants.) 42 (New Sugar Beet Pest.)

American Journal of Pharmacy, Mar., Apr. [Editor.]

Botanical Garden, N. York, Journ. Mar. Apr.

Botanical Gazette, Chicago, Feb. Mar. [Editor.]

Fern Bulletin, Apr.

Field Columbian Museum Publications, Chicago. Vol. I., No. 5. Aug. '99

Pennsylvania Univ. Publ, Cont. from Bot. Laboratory, Vol. II. No. I.

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Vick's Monthly, Dec. 1899. Feb. Mar. Ap.

Plant World, Mar. [Editor.]

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Trans. of Acad. Science of St. Louis. Vol. VIII. Nos. 8-12. Vol. IX. Nos. 1-5.

Puerto Rico. Reports of Brig. Gen. G. W. Davis on Arecibs, etc.
Report of Brig. Gen. G. W. Davis on Economic Conditions of Porto Rico.
Report of Brig. Gen. G. W. Davis on Civil Affairs of Puerto Rico.
[War Dept.]

SOUTH AMERICA.

Bolitim Inst. Agronomico, S. Paulo Brazil, Mao, Aug., Sept., Oct., 1899. [Director.]

POLYNESIA.
Planters' Monthly, Hawaii, Feb., Apr. [Editor.]

SEEDS.

From R. Botanic Gardens, British Guiana.
Castilloa elastica.
From Messrs. Dammann & Co., Italy.
Bergamot.
From Messrs. Herb & Wulle, Italy.
42 Packets of various seeds
From Dr. Morris, Barbados.
Pink Grape Fruit.
From Mr. W. Jekyll, Robertsfield.
Sweet Sop.
From Dr. Schiffman, St. Paul, Minn.
Atropa Belladonna.
From Royal Gardens, Kew.
Sempervivum montanum
Saxifraga cotyledon
Trilium grandiflorum
Delphinium grandiflorum
Typha latifolia
Sedum Aizoon
Butomus umbellatus
Spiraea filipendula
Corydalis capnoides
Hieracium aurantiacum
Escallonia rubra
Exochorda Alberti
Juniperus communis
Tamarix tetrandra
Widdringtonia Whytei
Berberis aquifolium
" Darwinii
Ceanothus azureus
Pyrus japonica
Rhamnus alternus
Potentilla alchemilloides
Camassia Cusikii
Geum Heldreickii
Eryngium amethystinum
Lotus corniculatum
Anthemis tinctoria
Alchemilla alpina
Fumaria capreolata
Ornithogalum nutans
Incarvillea Delavayi
Erica mediterranea
Cistus laurifolius
Rhamnus catharticа
Rosa rubiginosa
From the Queensland Acclimatization Society.
Licuala Mulleri
Xanthorrhea macronema (GrassTree)
Macrozamia Paulo-Gulielmi
Sterculia rupestris (Bottle Tree)
From Botanic Gardens Hong Kong.
Pinus Massoniana
Rourea santaloides
Quercus cornea (Edible Acorn of S. China and Hong Kong
Dendropanax parviflora
Nandina domestica
Lantana "Drop n'or"
Mucuna macrobotrys
Rhodoleia Championi
Jasminum paniculatum
Viburnum venulosum
Ilex memecylifolia
Scolopia chinensis
Enkianthus quinqueflorus
Rhus hypoleuca
From R. Gardens, Kew.
Acrostichum lomariodes
Codonopsis lanceolata
Plant like Gardenia—2 ft. high
Bastard Rhododendron—Pink flr. 4 to 6 ft. high (S. Shan States)
Spurious Rhododeendron—Piud yellow, 3 to 4 ft. high (S. Shan State.)
Large St. John's Wort } S. Shan States
Small St. John's Wort }
From Public Gardens, Nagpur, India.
Bhel Fruits
From Bot. Station, Barbados.
Phaseolus semierectus
From Bot. Station, Dominica.
Bois Pin (Talauma Plumieri,)

From Bot. Station, Saharanpur.
Artemisia vulgaris
Platanus orientalis
Acer pentaponicum
Olea cuspidata
Viburnum stellatum
Erigeron alpinus

From Bot. Gardens, Rockhampton.
Pterolobium nitens

From Messrs Damman & Co., Italy.
Picea excelsa

From Elmer Sterns, Los Angelos, Cal.
Japanese climbing cucumber
Echinocactus Wislizeni
Vine melon

From Bot. Station, Aburi, W. Africa.
Spathodea campanulata
Kicksia elastica

PLANTS.

From Mr. Agar.
Gold Ferns.

From Botanic Station Dominica.
Bananas (received in Oct. 1899.)
Pisang, Kelat, (Singapore)
" Palembong (Java)
" Radjo Hudang (Java)
" Soosoo (Java)
" maas (Java)
" Ambon (Java)
" Serch (Java)
Lady's Finger (Panshonger)
discolor (Kew)
oleracea (Brisbane)
Martaban (Calcutta)
cinerea (Saharanpur)
guindy (Ootocamund)
Bakerii "Tehi" (Kew)
rubra (Kew)
champa (Kew)
africana (Kew)

HERBARIUM.

From Prof. Urban.
128 Specimens

From Dr. Grabham.
Clusia flava (flowers)

From S. F. Noyes—Port Morant.
Green Ebony (leaves)

From C. Pengelly—Balaclava.
Green Ebony (leaves)

From Messrs. George and Branday.
Green Ebony (specimen of wood.)

From Mr. E. Haggart
Bitter Wood (specimen of woo d)

[Issued 26th May, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series | June 1900 | Vol VII — Part VI

RICE CULTURE IN THE UNITED STATES.—(*Continued.*)

GENERAL NOTES ON CULTURE AND TREATMENT OF RICE.

PREPARING THE GROUND.

Some planters advocate shallow ploughing for rice because it appears to thrive best in compact earth. Even if it be granted that the rice plant finds a more favourable condition in compact earth, it does not prove the superiority of shallow over deep ploughing. It has been demonstrated that the better the soil and the more thoroughly it is pulverised the better the crop. The roots of annual cultivated plants do not feed much below the plough line, so that it becomes evident that deep cultivation places more food within the reach of the plant. If pulverising the earth deeply be a disadvantage, by reason of the too great porosity of the soil at seeding time, it can be easily remedied by the use of a heavy roller subsequently. If the soil is well drained, deep ploughing will be found profitable. Deep ploughing just before planting sometimes brings too much alkali to the surface. The remedy for this is to plough a little deeper than the previous ploughing just after harvest; the alkali will then be washed out before the spring ploughing. The plough should be followed in a short time by the disk harrow and then by the smoothing harrow. If the land is allowed to remain in the furrow for any considerable time it will bake and can not be brought into that fine tilth so necessary to the best seed conditions. This is particularly true of rice land. If the best results are desired, it will be advisable to follow the harrow with a heavy roller. The roller will crush the lumps, make the soil more compact, and conserve the moisture for germinating the grain, rendering it unneccessary to flood for "sprouting."

SOWING.

Selecting the seed.—Too great care can not be exercised in selecting rice for seed. It is indispensable that the seed should be free from red

rice, uniform in quality and size of kernel, well filled, flinty, free from sun cracks, and free from all foreign seeds. Uniformity of kernel is more essential in rice than in other cereals, because of the polishing process.

Drilling.—The rice should be planted with a drill. It will be more equally distributed and the quantity used to the acre will be exact. The seeds will be planted at a uniform depth and the earth packed over them by the roller. It also prevents the birds from taking the seeds. The roller should precede the drill. If it follows the drill the feet of the horses, mules, or oxen drawing the roller will press some of the planted rice 4 or 5 inches deeper into the earth than the general average. Furthermore, the lumps of earth will prevent the uniform operation of the drill. In rice farming too much emphasis can not be placed upon the importance of thoroughly pulverising the soil to a considerable depth; levelling with a harrow as perfectly as possible; crushing all the lumps and packing the surface to conserve the moisture, and planting the seed at a uniform depth.

Broadcast sowing.—Broadcast sowing of rice should be discontinued; the seed is never scattered with uniformity; some grains remain upon the surface and the remainder is buried by the harrow and the tramp of the team to depths varying from 1 to 6 inches. Rice sown broadcast does not germinate with any uniformity. Some seeds are taken by the birds, some are too near the surface and lack moisture to germinate, while others are buried too deep. In some instances the variation in the germination of the rice in the same field has been as much as eight weeks. Then at the harvest when the main portion is ready for the reaper, quite an amount of the rice is still immature. The product commands a very low price in the market, because the merchantable grain must sell at the price of the low grade. Care must be taken to plant the several fields at different periods, so that the harvest will not be too crowded. It requires much more care to produce a strictly first-class quality of rice than is found necessary in the production of any other cereal, and nearly every fall prime offerings are the exception.

INJURY TO BLOOM.

If it is very showery during the period of bloom, pollination is frequently incomplete with consequent reduction in the crop. This rarely occurs with early planted rice. Occasionally the rice crop suffers from severe storms about the period of ripening. Fortunately these disasters are mainly local and limited to the equinoctial period. Otherwise rice has few enemies and may be regarded as the most reliable of all cereal crops. On this account, as well as for its food value, it has been adopted as the staple cereal in countries having a dense population, where any considerable failure of the crop would involve starvation for thousands.

FLOODING.

Depth of water.—Except where water is necessary for germinating the seed, flooding is not practiced until the rice is 6 to 8 inches high. If showers are abundant enough to keep the soil moist it is better to delay flooding till the rice is 8 inches high, as there is considerable

EXPERIMENTS IN JAPAN.

There is very little exact information on the subject of fertilisers for rice. In Japan and other oriental countries a large proportion of the rice lands is thoroughly fertilised in the fall with straw, leaves, rice hulls, fish, and night soil. The fields are planted to wheat or vetches for the winter crop, followed the next spring by rice without additional manures. While carefully done, there are no comparisons or data to show the actual advantage of fall fertilisation to the rice crop. At the Imperial College of Agriculture at Tokio, Japan, a series of experiments has been conducted on the same plats for nine years to determine the elements best suited to increase the yield of rice in Japanese soils. Four small plats were selected, planted with the same variety of rice, and treated in every way alike except in the application of fertilisers. For nine consecutive years a small amount of phosphate and potash was sown on plat No. 1; on plat 2, equal amounts of phosphoric acid and nitrogen; on plat 3, potash and nitrogen; on plat 4, potash, nitrogen, and phosphate. All these fertilisers were in an easily convertible form. At the expiration of the test the rice on plats 1 and 2 was medium in quality and quantity. That on plat 3 was very poor—could scarcely be called a crop—and that on plat 4 was very much superior to all of the others, clearly indicating the value of a complete fertiliser containing the three essential elements of plant food—nitrogen, potash, and phosphoric acid.

EXPERIMENTS IN LOUISIANA.

In Bulletins 15 and 24 of the Louisiana Experiment Station Dr. W. C. Stubbs has discussed this subject of manures for rice. He says: [1]

> Rice is not a great impoverisher of the soil, especially if the straw and chaff are regularly returned to it. Exactly how to apply manures to rice in order that they may accomplish the greatest amount of good possible, when the rice is soon to be inundated, is yet an unsettled question. For the two years of the experiment the various fertilisers have been scattered broadcast over the soil before being broken. The soil has then been inverted and harrowed and rice sown. This mode of application has not been satisfactory. The increased results, while sometimes apparent were not large.

The largest yield was obtained from an application of 300 pounds of cotton-seed meal, 150 pounds of acid phosphate, and 50 pounds of kainit spread on the surface of the ploughed ground just before the seed was harrowed in. The same fertilisers used singly or in combinations of only two did not increase the yield of either straw or grain when spread on the ground and ploughed under. The increase for the first mixture amounted to 25 per cent. of both straw and grain. Where ploughed under, the fertilisers seem to have been buried too deep to produce any noticeable effect.

While these conclusions are not final, Dr. Stubbs recommends the use on black soils of two parts of cotton-seed meal and one part acid phosphate, mixed and applied broadcast before the rice is harrowed in. On sandy land he would add kainit at the rate of 200 pounds to the acre. In Bulletin 24 there is the following additional report: [2]

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1 Bul. 15, p. 1888. 2 Bul. 24, p. 365. 1889.

On April 25, 1898, the ground was broken and harrowed, fertiliser distributed broadcast, rice sown, and both harrowed in together. This was nicely accomplished by harrowing both ways. The following are the experiments with manures used per acre :

Plat No. 1. No fertiliser, yielded 1,382 pounds of grain.

Plat No. 2. Seventy-five pounds sulphate of ammonia, yielded 1,392 pounds of grain.

Plat No. 3. Three hundred pounds cotton-seed meal and 150 pounds acid phosphate, yielded 1,664 pounds of grain.

Plat No. 4. Seventy-five pounds dried blood and 37 pounds bone meal, yielded 1,543 pounds of grain.

Plat No. 5. No fertiliser, yielded 1,056 pounds of grain.

Plat No. 6. Two hundred pounds cotton-seed meal, yielded 1,344 pounds of grain.

Plat No. 7. Two hundred pounds cotton-seed meal and 100 pounds acid phosphate, yielded 1,884 pounds of grain.

Plat No. 8. One hundred pounds of cotton-seed meal, 25 pounds of fish scrap, 25 pounds nitrate of soda, and 100 pounds of acid phosphate, yielded 1,677 pounds of grain.

Plat No. 9. No fertiliser, yielded 1,559 pounds of grain.

These results are quite unsatisfactory, because there is a wide divergence in the yield between the best and poorest unfertilised plots. The difference in yield between plots 9 and 7 is not so marked as between 9 and 5, and the increase from the use of the best of the fertilisers amounts to little more than the cost of the application.

It is quite probable that the yield depends as much on the thorough aeration of the soil and the abundance of the organic matter present as on the mineral elements. Complete drainage in winter,followed by deep ploughing and then disking, harrowing, and rolling until the seed bed is fine, will probably serve better to increase the yield than an application of the best commercial fertilisers without proper cultivation. This can be supplemented by an occasional summer crop of cowpeas or velvet beans to supply humus and organic nitrogen.

SOILS ADAPTED TO RICE.

The best soil for rice is a medium loam, containing about 50 per cent of clay. This allows the presence of sufficient humus for the highest fertility without decreasing too much the compact nature of the soil. The alluvial lands along the Southern rivers, where they can be drained, are well adapted to rice cultivation. Occasionally such lands are too sandy. The rich drift soils of the Louisiana and Texas prairies have shown a marvellous adaptation to rice. These soils are underlaid with clay so as to be retentive of water. The sand is exceedingly fine. There is about the right proportion of potash, phosphoric acid, other essential mineral elements, and humus to be lastingly productive. They are sufficiently remote from the coast to be free from devastating storms and the serious attack of birds. There is no expensive clearing, ditching, or leveeing to prepare the lands for rice. The drainage is good and the lands can be cultivated to winter crops, thus preventing the growth of red rice and injurious weeds and grasses. Such cultivation enables the planter to plough deeply in the fall and fertilise.

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Ploughing when done in the spring should be shallow. Rice roots are not deep feeders. Showing its wide range of adaptation, rice from the same sack has been planted in moist land and flooded ; in cultivated upland fields and on levees 18 inches above the water. For a time it grew with almost equal vigour under each of the foregoing conditions. The principal difference appeared in the maturing of the seed. Trials have been made with soils covered with a large amount of decayed vegetation. The results were generally disappointing. The roots of the rice, being shallow feeders, did not gain much hold upon the soil, and the proportion of mineral matter and silicates in the decayed vegetation was not adapted to the rice plant. Rice has generally failed on peaty soils.

Gravelly or sandy soils are not adapted to rice cultivation because they do not possess the mechanical conditions for the retention of water. Occasionally, on a light sandy soil, underlaid by a stiff subsoil, one or two fairly good crops of rice may be secured, but this is the limit.

WAGES AND EFFICIENCY OF LABOUR IN DIFFERENT COUNTRIES.

The great variations in wages and in the area which can be cultivated by the labourer in different countries are shown in the following table:—

Number of acres one man can farm in rice, with wages, in different countries.

Countries.	Acres.	Farm wages in gold per year, with board.	Countries.	Acres.	Farm wages in gold per year, with board.
Japan - -	½	$10 to $18	Spain - -	5	$40 to $60
China - -	½ to 2½	8 to 12	United States:		
Philippines - -	2½	15 to 20	Carolinas -	8	92 to 120
India - -	3	10 to 20	Mississippi delta	10	120 to 144
Siam - -	3	10 to 20	Southwestern		
Egypt - -	4	15 to 30	Louisiana and		
Italy - -	5	40 to 60	Texas - -	80	180 to 216

(To be Continued.)

POTATO SCAB.

A correspondent has sent up samples of potatoes badly affected by scab disease. Until a few years ago potato scab was supposed to be due to mechanical irritation in the soil, damages resulting from insect agencies, chemical erosion or irritation, excess of moisture, etc., but from the contradictory nature of the observations recorded it is clear that the disease and its causes were not understood. It is now known that scab is caused by the growth of at least one fungus, (*Oespora scabies*) and possibly others will be detected

in the course of time by officers of the Experiment Stations who are investigating the disease. The following notes on the subject are taken from the Bulletin of the Kingston, Rhode Island Agricultural Experiment Station, Nos. 26,33 and 40. W. H.

The valuable and carefully conducted investigations by Bolley [1] and Thaxter [2] seem to have conclusively established the fact that the disease of the Irish potato, known as the potato "scab" is the direct result of the development upon the tuber of one or more fungi [3] or minute plant organisms. Heretofore this disease had been attributed by various investigators to a number of different causes and the many theories and practical observations on record, furnish by their contradictory nature, conclusive evidence that the character and cause of the disease was not understood. Now that the direct cause has, in all probability, been ascertained, many of the heretofore conflicting observations have found their explanation or have been discarded by some as probably unreliable, because no satisfactory explanation for them has yet been offered.

It is not our purpose to discuss at length all of these theories and observations, extended references to which may be found in the papers by Humphrey[4], Thaxter[5] and Bolley[6]. Four of these discarded theories as to the direct cause of the potato scab are the following: "(1) mechanical irritation; (2) damages resulting from insect agencies; (3) chemical erosion or irritation; (4) excess of moisture." It is a matter of common observation that if the surface of a plant or tree is injured, nature at once attempts to cover or repair the injured place by producing an abnormal growth about the point of the injury. In fact the four above mentioned theories were based upon the idea that refuse materials, coarse manures, chemical manures, and among them those which tended to set free ammonia within the soil, as well as an excess of moisture and and insect depredations, were all capable directly or indirectly, of imparting injury to the surface of the growing tuber and thus engendered the disease. It is self-evident that these theories in light of the recent investigations of Bolley and Thaxter are no longer tenable, or rather that they do not explain the direct cause of the scab disease.

From what has been learned by various investigators up to date, in relation to the potato scab, it appears: (1) That the scab is caused directly by the growth of a fungus upon the potato tuber. (2) That if the "seed" tubers and the soil are from the germs the crop will remain free from the scab if not contaminated by germs introduced in some manner as upon manures, implements of tillage, etc. (3) That the disease is liable to be spread by barn-yard manure. (4) That

1. See Agricultural Science, Vol. IV, No. 9, p. 248. Vol. IV, No. 10, p. 277, and Buls. 4 and 9 of the N. Dak. Agr'l. Exp't Station.

2. An Rpts. Conn. Agr'l Exp't. Station for 1890, p. 81 and 1891, p. 153 and Bulletin 105.

3. Oospora scabies is the name applied by Thaxter to the fungus of "deep" scab.

4. Sixth An. Rpt. Mass. State Arg'l Exp't Station, 1888, pp. 131-138.

5. l. c.

6. l. c.

smooth tubers may still bear the germs of the disease if they have come in contact with scabby ones or have been put in bags, bins, etc., where scabby potatoes have previously been placed. (5) That the only way to insure a smooth crop is to avoid planting the potatoes on land which has been previously contaminated, to avoid the introduction of the germs on the manures and implements used, and to treat the tubers before planting in such a way as to kill any germs already upon them. (6) That if the germs are present in the soil, or are introduced on the tubers, the character of the soil and the nature of the manures; (even if the latter are free from the germs) may under certain conditions exert a decided influence on the development of the scab. (7) That no practical means has yet been devised for destroying the germs of the disease in soils already infested with them. (8) That of all the methods of treatment of the seed tubers and soil none of them seem to give fully satisfactory results in case the soil is already badly contaminated with the germs. (9) That treatment of the seed tubers with bichloride of mercury is a very effectual means of lessening the scab if uncontaminated soil is employed, and if all other means of contamination are avoided. (10) That on soils which are acid, if lime and ashes are employed in such a quantity as to make the soil practically neutral or but slightly acid, there is probably danger of increasing the scab, provided the soil, seed tubers, or manures are contaminated with the germs of the disease. If the soil and manure are free from the germs, and the tubers can first be effectually treated, then liming can probably be resorted to without hesitation. (11) That an acid condition of the soil is unfavourable to the growth of the potato and probably to the fungus which produces the scab, and that it is desirable to know with certainty how to avoid the disease and at the same time to increase, by liming, the yield of merchantable tubers. 12. That if potatoes are scabby they should be dug early.

The best method of treatment now known for the destruction of the germs of the fungus of the potato scab seems to be the corrosive sublimate treatment employed by Bolley [1] and others.[2]

Treatment. Corrosive sublimate can be bought at drug stores in the form of crystals. Two and one-fourth ounces of these crystals should be dissolved in a few gallons of hot water and enough cold water added to make fifteen gallons of solution; the whole should then be well stirred. In preparing the solution, and treating the seed use wooden vessels only. Two barrels with wooden faucets are convenient, the solution being drawn from one to the other whenever it is desired to remove the potatoes. The potatoes may also be put in a sack and dipped into the solution. The same solution may be used repeatedly. The whole tubers after first being washed should be placed in the solution for one and a half hours, then spread out to d ry, and cut and planted as usual.

Various methods of treatment of the seed tubers for the accomplishment of the above mentioned object have been resorted to by various experimenters, but the treatment proposed by Bolley, viz: that with

1. Bulletins 4 and 9 of the N. Dak. Agr'l. Exp't Station.

2. Kinney, 5th An. Rpt. R. I. Exp't Station, pp. 211-212. New York Agr'l Exp't Station, Geneva, Bul. No. 49, New Series. T. B. Terry, Our Farming, 1893, p. 206.

corrosive sublimate solution as described in Bulletin No. 26 of this Station, page 155, has shown itself to be the most satisfactory of any yet resorted to. In fact the cost of the material required for the treatment of several bushels of seed tubers amounts to but a few cents, and the results secured upon most soils have been so excellent that no grower of potatoes who uses lime, wood ashes, or barn-yard manure, or who finds that his soil is already in such a condition that upon the introduction of the germs, a scabbed crop results, should fail to resort to the treatment at once. The time of treatment which Bolley recommends is one and one-half hours, and in Bulletin 4 of the North Dakota Station, page 14, he recommends the use of 2 ozs. of corrosive sublimate to fifteen gallons of water, which gives a solution of about 1 to 1,000. In Bulletin 9 of the same Station, he recommends two and one-fourth ounces to the same amount of water or a stronger solution, but nevertheless states on page 30 of the same bulletin that the spore bodies "are destroyed by contact with a 1 to 1,000 solution of corrosive sublimate in a comparatively short time." The strength of the solution employed by us was 2 ozs. to fifteen gallons of water, and the treatment was continued one and one-half hours, which, in view of the above mentioned statements and directions, was supposed to be all that was considered necessary for the accomplishment of the object; and this treatment must have met all the requirements of the case, if, as Bolley states, he has never failed to destroy all scab fungus upon the most deeply scabbed seed tubers, for apparently the strength of solution was the same as that used by him in a portion of his work. In support of our own results, which indicate that some germs may escape destruction by the treatment, and also that the strength of solution employed by us could not be used as an argument against our results, we cite the following experience of others, viz: L. R. Taft, of the Michigan Station,[1] states that "corrosive sublimate, 1 part to 2,000 seems to be as effective as 1 part to 1,000. He also states [2] that soaking the seed longer than one and one-half hours may lessen the scab still more, but it reduces the yield." C. F. Curtis, of the Iowa Station, [3] found, when using a solution containing two and one-quarter ounces of corrosive sublimate to 15 gallons of water, that a treatment for two hours produced less scab in the product than a treatment for one and one-half hours. J. E. Arthur, of the Indiana Station, [4] reports results secured in 1893 with corrosive sublimate solution made of a strength of 1 to 1,000 in which a treatment for two hours was more effective than that for one and one-half hours. James Troop, of the Indiana Station, [5] has tabulated the results of three of his experiments in, which by the use of a soltion of 1 to 1,000 the per centage of scab was in every case decreased by extending the treatment from one and one-half, to three hours. Y. P. Clinton, of the Illinois Station, [6] is also of the opinion that a treatment of three hours is more effective than one of an hour and a half.

Other experiments as well as that by Troop, above mentioned, point to the conclusion that certain soils, at least, act themselves

1. Bull. 108. p. 44.
2. l. c.
3. Bull. 27, p. 126.
4. Bull. 56, pp. 72 and 73
5. Bull. 53, p. 122.
6. Bull. 40, p. 144.

as disinfectants, either due to particular compounds produced within them or to their natural acidity. Our own results in this and previous years point strongly to the conclusion that either the acidity or alkalinity of soils or else the presence of carbonates within them, determines in a great measure the injury which may be expected from potato scab when the germs of the disease are once introduced into them. The difficulty of settling satisfactorily the particular point as to whether it is the presence of carbonates or the reaction of the soil as concerns acidity and alkalinity, will be more readily apparent when we bear in mind that such substances as are capable of counteracting the acidity of soils are either carbonates or are changed into carbonates by natural processes within the soil, subsequent to their application.

GENERAL SUMMARY IN RELATION TO THE POTATO SCAB.

1. Experiments for three years show that the growth of the potato scab fungus is promoted by the presence of air-slacked lime.

2. Calcium sulphate (known as land plaster and gypsum) is the only form of lime employed which has not injured the growth of the crops, and which has at the same time failed to promote with certainty the development of the scab.

3. Barnyard manure, owing to its alkalinity or the production of carbonates from it, has probably in and of itself increased the scab.

4. By the use of air-slacked lime, wood ashes, barn-yard manure, soda ash (sodium carbonate), or double carbonates of potash and magnesia, the production of scab would be favoured.

5. If favourable for its development, the fungus seems to multiply in the soil independent of the continual presence of potatoes or or other root crops, though how long this is possible without the occasional intervention of some root crop is unknown.

6. The results show the danger liable to follow even if a few germs are introduced into the soil, provided it is of itself, or has been made by injurious fertilisation, highly favourable to the development of the scab.

7. It is shown in a striking manner that the *corrosive sublimate* or some other satisfactory treatment of the seed tubers should always be resorted to on soils which are favourable to the development of the potato scab.

8. Upon our acid soil practical immunity from scab has been secured upon three successive crops by the use of fertilisers representing our ordinary commercial fertilisers, even when slightly scabbed untreated seed tubers have been employed.

9. The results with calcium compounds also accord closely with those of 1894 and 1895. A scabless product was produced where calcium chlorid or land plaster (gypsum) was used. Calcium chlorid had a marked poisonous effect upon the potato plants and nearly destroyed them. Land plaster appeared not to have increased, and it may have lessened, the yield slightly. Where calcium at the same rate as in the calcium chlorid and land plaster was applied in the form of wood ashes, air-slacked lime, calcium carbonate, calcium oxalate and calcium acetate, the vigour of the plants and the yield of tubers were wonderfully increased, but the crop was so badly scabbed as to be worthless.

10. Where the fertiliser was used without any lime compounds no scab resulted, showing that the acid soil must have rendered dormant, or destroyed the scab fungus introduced on the scabbed seed tubers of the two previous years.

11. The treatment of the seed tubers with a 1 to 1,000 solution of *corrosive sublimate* for one and one-half hours was utterly useless where the soil was favourable to the disease, and where it was already badly contaminated by two preceding lots of scabbed seed tubers and scabbed crops. In other experiments by us heretofore where the soil was favourable to the disease, but where little or no contamination already existed, Bolley's *corrosive sublimate* treatment proved highly effective. It is probable that some germs escape even this treatment, but fewer, of course, where the seed tubers are not scabbed, so that there is danger if potatoes and root crops are grown frequently that serious contamination may nevertheless result eventually. The necessity, on land intended for potato growing, of avoiding the frequent use of fertilisers which tend to make the soil more favourable to the development of the scab fungus is therefore obvious.

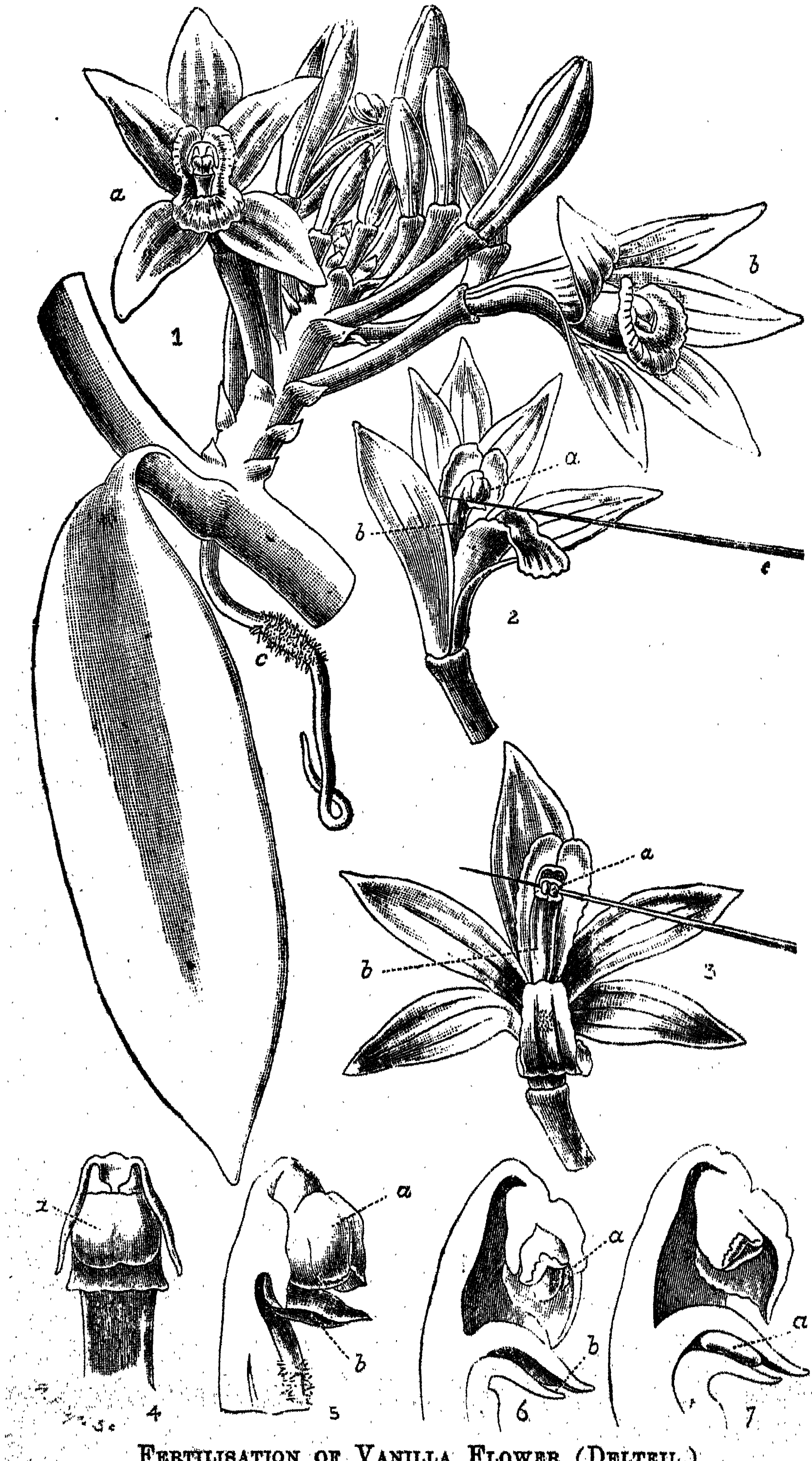
12. The materials which favour the scab and which are at times applied to land are ; stable manure of all kinds, wood ashes, air-slacked or caustic lime and carbonates of soda (soda ash), potash, lime and magnesia.

13. The materials which do not tend to make the scab worse and which may decrease it, are most commercial fertilisers, sea-weed potash salts, (excepting potassium carbonate) land plaster, common salt and ammonium sulphate. Sodium nitrate (Chili salt-petre) if used in large quantities may favour the scab eventually, but from the amounts usually applied no serious results would be expected to follow. In case a soil were badly contaminated and favourable to the disease, superphosphate, ammonium sulphate, kainit, sulphate and nuriate of potash are materials which, applied as fertilisers would tend gradually to alleviate the conditions.

14. Sulphur (the remedy proposed by Halsted) when mixed thoroughly with the upper seven to eight inches of a badly contaminated soil favourable to the disease, though checking the scab somewhat, was practically useless.

15. The treatment of seed tubers by rolling in sulphur and sprinkling the balance in the row at the rate of 300 pounds per acre is claimed by Halsted to be quite effective. The use of the very poisonous *corrosive sublimate* solution would be thereby avoided, yet the additional expense of the sulphur over the corrosive sublimate treatment for this purpose militates against its use in that way where potatoes are grown at the present low prices.

16. The marked acidity (sourness) of soils, or the absence of carbonates in them seems to indicate their ability to produce a scabless product even when untreated seed tubers are used.



FERTILISATION OF VANILLA FLOWER (DELTEIL.)

VANILLA.

In the article on Vanilla, in last issue of the Bulletin, reference is made to a drawing of the flower and its parts in Bulletin for Oct. 1888. That drawing is now reproduced for the benefit of those who may not possess a copy of the earlier Bulletin.

Explanation of Plate.

Fig. 1.—Portion of stem of Vanilla plant, with leaf, aerial root, and cluster of flowers ; *a*, front view of Vanilla flower ; *b*, side view ; *c* aerial root, with root hairs.

Fig. 2.—Single flower of Vanilla, exhibiting the first stage in the process of artificial fertilisation. The operator, provided with a finely-pointed piece of bamboo, divides the lip or labellum medially, so that the central lobe is separated from the two side lobes. This exposes the column and organs of fecundation. The instrument is represented as placed against the column, ready to press upwards the anther *a*, and bring the pollinia in contact with the stigma *b*.

Fig. 3.—Single flower of Vanilla, exhibiting the second stage in the process of artificial fertilisation ; *b* shows position of column exposed by division of the lip [the middle lobe of lip is pulled forward and curled upon itself to show the position of the column ; the side lobes of lip, separated as shown in Fig, 2, are represented at back of the column] ; *a*, the position of pollen masses, taken from the anther and placed on the stigma.

Fig. 4.—Enlarged front view of top of the column ; *a*, the anther.

Fig. 5.—Enlarged side view of top of the column ; *a*, the anther ; *b*, the stigma, or viscid surface on which the pollen masses must be placed to ensure fertilisation.

Fig. 6.—Enlarged section through top of the column ; *a*, one of the pollen masses *in situ* ; *b*, the stigmatic cavity.

Fig. 7.—Enlarged section through top of the column ; *a*, the pollen masses, having been transferred from *a*, Fig. 6, are now represented in contact with the stigmatic surface. [Although diagrammatically shown, these figures give a tolerably good idea of what is actually necessary in order to produce fertilisation in a Vanilla flower.]

SALT BUSHES.

Dr. Hilgard, Director of the Agricultural Experiment Station, University of California, was applied to recently for seeds of Salt Bushes, notes on which were given in Bulletin for August 1896, and in his reply occurs the following paragraph :—

" As you of course understand, the salt bushes require a dry, deep soil and will not do well under ordinary tropical conditions. They resent bottom-water at a less depth than four or five feet, and will go ten and twelve where they can. From Mr. Hill's description of your Island, however, I have learned the unexpected fact that you have an arid leeward side, where cacti and yuccas grow, and this, I imagine, will be the best region for the salt bushes ; but I would advise sowing them in boxes and setting out the plants when a few inches high ; they will probably need no watering in your climate, and when once established, the A. semibaccata especially, will take care of its own propagation."

:o:

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT

LIBRARY.

Europe.

British Isles.

Botanical Magazine, May. [Purchased.]
British Trade Journal, May. [Purchased.]
Bulletin Kew Gardens, Apr. 11. [Director.]
Chemist and Druggist, Apr. 21, 28. May 5, 12. [Editor.]
Garden, Apr. 21, 28, May 5, 12. [Purchased.]
Gardners' Chronicle, Apr. 21, 28, May 5, 12. [Purchased.]
Hooker's Icones Plantarum, May. [Bentham Trustees.]
Journal of Botany, May. [Purchased.]
Journal R. Colonial Institute, May. [Purchased.]
Nature, Apr. 26, May 3, 10 [Purchased.]
Pharmaceutical Journal, Apr. 21, 28, May 5, 12. [Editor.]
Produce World, May. [Editor.]
Sugar, Apr. [Editor.]
International Sugar Journal, May. [Editor.]
W. Indian and Com. Advertiser, May. [Editor.]

France.

Sucrerie, indigene et coloniale, Apr. 24, May 1, 8, 15. [Editor.]

Germany.

Notizblatt, Berlin, July, Oct. 1898. [Director.]
Beihefte zun Tropenpflanzer, May. [Editor.]

Italy.

Palermo, Bol. Ort. Bot., Fasc. I-IV. 1899. [Director.]

Switzerland.

Memoires de l'Herbier Boissier. Nos. 11, 12, 13. [Conservateur.]

Asia.

India.

Report Gov. Gards. Mysore, for year 1898-99. [Director.]
Planting Opinion, Mar. 31, Apr. 7, 14, 21, 28. [Editor.]

Ceylon.

Times of Ceylon, Apr. 14-26. [Editor.]

Africa.

Cape of Good Hope.

Agri. Journ., Mar. 29. [Dept. of Agr.]
Central African Times, Mar. 3, 10, 17, 24, 31. [Editor.]
Agr. Journ. and Mining Record of Natal. Apr.

West Indies.

Barbados.

Agricultural Gazette, Apr. [Editor.]
Moth Borer in Sugar Cane. By Mr. H. Maxwell-Lefroy. [Com. Imp. Dept. Agr.]

Jamaica.

Journal, Jamaica Agri. Soc., May. [Secretary.]
India Rubber, Gutta Percha and Balata. [W. I. Chem. Works, Ltd.]

Trinidad.

Bot. Garden, Bulletin, April. [Supt.]
Bot. Garden Report for 1899. [Supt.]

Japan.

Bulletin, College of Agri., Feb.

Australia.

N. S. Wales.

Agri. Gazette of N. S. Wales, Apr. [Dept. of Agr.]

Queensland.

Queensland Agri. Journal, Apr. [Sec. Agr.]
Queensland Sugar Journal, Apr. [illegible]

British North America.

Montreal.

Pharmaceutical Journal, May. [Editor.]

Ontario.

Reports of Poultry Associations for 1899.

United States America.

Publications of the U. S. Dept. o Agriculture.

Scientific Bureaus and Divisions. (*Directors.*)

Division of Botany, 24 [Germination of seeds affected by Chemical tilizers.]

Experiment Stations.

Illinios. 57 (Smuts of Illinois Agr. Plants) Composition and Digestib of Corn Fodder add Corn Stover) 59 (Orchard Management.)
Kansas. 95 (Farm Department) 96 (Soil Inoculation for Soy Beans)
Kentucky. 84 (Elms and their Diseases) 85 (Cornmeal Fertilizers)
Maine. Report for 1899 Pt. 11.
Minnesota. 67 (Feeding Dairy Cows.)

New Jersey, Report to Oct. 31st 1899.
New York. (67 (Fruit Disease Survey of Hudson Valley in 1899) 168 (Director's Report for 1899) 169 (Fertilizing Self-Sterile Grapes) 170 (Diseases and Insects injurious to Fruits) 171 (Animal Food for Poultry) 172 (Efficiency of Continuous Pasteurizer at different Temperatures) 175 (Parasite upon Carnation Rust.)
Texas. 56 (Investigation and Improvement of American Grapes)
Virginia Report for 1898-'99. 76 (Forest Caterpillar) 77 (Analyses of Commercial Fertilizers) Spray Calendar.
Wisconsin. 36 (Aspects of Mental Economy.)
American Journal of Pharmacy, May. [Editor.]
Botanical Garden, New York, Journ., May.
Botanical Gazette, Chicago, Apr. May. [Editor.]
Torrey Club Bulletin, May [Editor.]
Plant World, Apr. [Editor.]
Work of U. S Dept. of Agr. on Plant Hybridistion. By H. J. Webber.
Foreign Trade of Puerto Rico American Occupation. By Brig. Gen. G. W. Davis. [War Dept]

SEEDS.

From Agr. Exp. Station, Berkeley' California.

Rhamnus californica
Myrica californica
Cerasus ilicifolius, var. integrifolius
Alectryon excelsum
Atriplex semibaccatum
Atriplex leptocarpa
Atriplex halimodes
Juniperus sp.
Tacsonia mixta
Physalis Francheti
Eucalyptus corynocalyx
Glaucium flavum
Tacsonia mollissima
Coreopsis Drummondii.
Oenothera biennis grandiflora.
Linum sibiricum
Vitis californica
Lathyrus ordoratus
Cytisus proliferus albus
Cupressus macrocarpus
Linum grandiflorum
Eucalyptus calophylla
Lathyrus stans
Coreopsis tinctoria
Sollya heterophylla

From Bot. Gard. Ootacamund—Madras, India.

40 pkts Seeds (Burnt) *

Mr. Jekyll, Robertsfield.

Browallia speciosa major
Nicotiana sylvestris

K. Tomlinson, Lacovia.

Lagetta lintearia (Lace Bark)

* Burnt on receipt, as there is a Government prohibition against receiving [seed]s or plants from these colonies for fear of introducing the Coffee Leaf [Dise]ase, *Hemileia vastatrix.*

[Issued 22nd June, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] JULY, 1900. Vol. VII. Part VII.

RICE CULTURE IN THE UNITED STATES.

(*concluded.*)

PRIMITIVE RICE MILLING.

The primitive method of milling rice was to place a small quantity in a hollow stone or block of wood and pound it with a pestle. The blow with the pestle cracked the hull, and the friction created by the sliding motion of the rice under the blow removed the hull and the cuticle. The bran and hulls were then removed by winnowing. The first advance upon this primitive mechanical process was to make the receptacle for the rice out of a short section of a hollow log, using a heavy wooden pounder bound to a horizontal beam 6 to 8 feet long, resting on a fulcrum 4 to 5 feet from the pounder. The pounder was raised by stepping on the short end of the beam, and by suddenly removing the weight the pounder dropped into the rice tub and delivered a blow. The end of the pounder was concave with edges rounded. This simple machine and the fanning mill are in common use in oriental countries to this day.

As one passes along the street in an oriental city, a peculiar sound is brought to the ear as of a blow delivered upon some yielding substance. Looking to the right or left one sees a rice mill, consisting of a one-man power jumping on and off the beam of the pounder and one-woman power at a crude fanning mill cleaning the grain. Such a mill cleans about 11 bushels (a trifle over three barrels) of paddy rice per day, at a cost of 6 cents (gold) per barrel.

In time water power was used to turn an overshot wheel, which was geared to a long horizontal shaft with arms at distances apart equal to that of the rice pounders. The rice pounder was a vertical beam about 10 feet long and 6 inches square, with a pin projecting at a point to be caught by the rounded end of the arm of the revolving shaft, which raised the pounder a short distance then slipped past the pin, allowing the pounder to drop into the tub of rice. This process was repeated until the hull and bran were removed. The rice tubs stood in a row as closely as practicable for use. Generally, to economize space, there were two shafts revolving in opposite directions, allowing two rows of rice tubs. In every mountain village in Japan such mills may be found preparing the rice for local consumption. They usually have about

eight pounders and mill 96 bushels daily, or 26⅔ barrels, of paddy rice, at a cost of about 2 cents per barrel, which is more than paid for by the offal. In cities steam power is used and the number of pounders greatly increased, but the process is practically unchanged.

COMMERCIAL RICE MILLING.

The usual process.—The processes of milling rice are quite complicated. The paddy is first screened to remove trash and foreign particles. The hulls, or chaff, are removed by rapidly revolving "milling stones" set about two-thirds of the length of a rice grain apart. The product goes over horizontal screens and blowers, which separate the light chaff and the whole and broken kernels. The grain is now of a mixed yellow and white color. To remove the outer skin the grain is put in huge mortars holding from 4 to 6 bushels each and pounded with pestles weighing 350 to 400 pounds. Strange to say, the heavy weight of the pestle breaks very little grain.

When sufficiently decorticated, the contents of the mortars, consisting now of flour, fine chaff, and clean rice of a dull, filmy, creamy color, are removed to the flour screens, where the flour is sifted out. From thence the rice and fine chaff, go to the fine-chaff fan, where the fine chaff is blown out and mixed with the other flour. The rice flour, as we call it, or more properly "rice meal," as our English neighbours call it, is very valuable as stock feed, being rich in carbohydrates as well as albuminoids.

From the fine-chaff fan the rice goes to the cooling bins, rendered necessary by the heavy frictional process through which it has just passed. It is allowed to remain here for eight or nine hours, and then passes to the brush screens, whence the smallest rice and what little flour is left pass down one side and the larger rice down the other.

The grain is now clean and ready for the last process—polishing. This is necessary to give the rice its pearly lustre, and it makes all the difference imaginable in its appearance. The polishing is effected by friction against the rice of pieces of moose hide or sheepskin tanned and worked to a wonderful degree of softness, loosely tacked around a double cylinder of wood and wire gauze. From the polishers the rice goes to the separating screens, composed of different sizes of gauze, where it is divided into its appropriate grades. It is then barrelled and is ready for market.

An improved process.—In mills more recently erected the foregoing process has been modified by substituting the "huller" for the mortar and pounder. The huller is a short, cast iron, horizontal tube with interior ribs and funnel at one end to admit the rice. Within this tube revolves a shaft with ribs. These ribs are so adjusted that the revolution of the shaft creates the friction necessary to remove the cuticle. The rice passes out of the huller at the end opposite the funnel. It resembles externally a large sausage machine. It requiries six hullers for each set of burs. The automatic sacker and weigher is used instead of barrelling, sacks being preferred for shipping the cleaned rice. Sheepskins are used for polishing.

With the above modification of the milling processes considerable reduction has been made in the cost of the mill. Mills of a daily capacity of 60,000 pounds of clean rice can now be constructed at a total cost of $10,000 to $15,000.

A portable mill.—A portable rice mill has also been devised for plantation use, costing $250, aside from the power to run it, and capable of cleaning 8,100 pounds of paddy rice per day. Such small machines do not give the finish required by the general market, but turn out excellent rice for local use.

EFFECTS OF FASHION IN RICE.

It is to be regretted that fashion has so much to do with rice. It requires a high gloss, and to obtain this the most nutritious portions are removed under the polishing process. Estimated according to the food values, rice polish is 1.76 times as valuable for food as polished rice. The oriental custom, much used by farmers in the South, of removing the hulls and bran with a pounder and using the grain without polishing is economical and furnishes a rice of much higher food value than the rice of commerce. In the process of polishing nearly all the fats are removed. In 100 pounds of rice polish there are 7.2 pounds of fats. In 100 pounds of polished rice there is only 0.38 pound of fat. Upon the theory that the flavor is in the fats it is easy to understand the lack of it in commercial rice, and why travellers universally speak of the excellent quality of the rice they eat in oriental countries.

Grades and prices.—Aside from the loss in flavor and nutritive value by polishing, fashion again increases the cost of commercial rice by demanding whole grains and places a value of about 2 cents per pound more than head rice (whole grains) than on the same quality slightly broken. The weekly New Orleans market report for June 3, 1899, makes the following quotations on cleaned rice per pound.

		Cents.			Cents.
Fancy	...	6	Ordinary	...	3
Choice	...	5¼	Common	...	2½
Good	...	4¼	Inferior	...	1¾
Fair	...	3¾	No. 2	...	1⅝

These grades are determined not by the difference in quality, but by appearance, and may be manufactured from the same quality of paddy rice. Ordinary a choice lot of paddy would yield three qualities of rice: Whole grains grading "fancy," "choice," or "good;" "fair" or "ordinary;" and No. 2, consisting of fragments and broken grains

The president of the New Orleans Board of Trade, Hon. S. Kock Breaux, states that "the basis of grades of clean rice is predicated upon the size of the bean, its brilliancy (high polish), and general appearance, each lot presenting individual characteristics that to the buyer add or detract from its normal value." The following official quotations of the New Orleans Board of Trade for June 16, 1899, are in point:

Spot quotations, per pound, clean ; quiet but steady:

No. 2	...	...	1⅝ to 1¾
Inferior	...	..	1¾ to 2
Common	...	...	2½ to 3
Screenings	...	...	2 to 2¾
Ordinary	...	...	3 to 3¾
Fair head	...	...	3¾ to 4¼
Good head	...	...	4¼ to 4¾
Prime head	...	...	4¾ to 5⅛
Choice head	...	..	5¼ to 5¾
Fancy head	...	...	6 to 6½
Extra fancy	...	...	6½ to 6¾

There may be a slight difference in food value between No. 2 (fine rice sold to brewers) and extra fancy, but if any it is trifling. If rice is to enter largely into the list of economic foods for the use of the masses, grades must be established based on the food values and not on the shine of the surface. It would be just as sensible to place a price on shoes according to the polish they will take.

LOSS BY BREAKAGE IN MILLING.

We are now prepared to understand the loss by breakage of the kernel in milling. If the grain remains whole and is sufficiently hard to receive a high polish it sells for 6½ cents per pound. If it breaks it drops in price 2 or 3 cents per pound, and if it crumbles so that the particles will pass through a No. 12 seive the price is 1⅝ cents per pound. The question is, What is the average breakage per 100 pounds and how can it be remedied? Investigations made among the rice millers in 1897 led to the conclusion (based upon their written statements) that the perfect grains were only about 40 per cent of the total product. Recent letters addressed to the various rice mills have failed in most cases to elicit the information. The president of the New Orleans Board of Trade states in a letter: The second part of your letter we are unable to answer as a proposition, for the reason that different mills achieve different results, and there is no way by which the trade can arrive at an average of the yield made by the different mills, this information as a rule being carefully guarded." In the few reports received the grading of the milled product was so different that no conclusion could be drawn as to the relative amount obtained by the mills. In the mills reporting, the best lots of rice milled last season showed a breakage of 21½ to 40 cent and the poorest lots showed from 65 to 100 per cent breakage. The best lots of rice gave from 100 to 112.9 pounds of milled rice from 162 pounds of paddy; the poorest gave only from 63.6 to 85 pounds from the same quantity paddy.

RESULTS OF MILLING.

The following tables show the percentages obtained per barrel of 162 pounds by three different mills:

Report of a mill having a daily capacity of 1,200 barrels.

Grades.	In best lot.	In poorest lot.
	Pounds.	*Pounds.*
No. 1 or head rice	91.32	...
No. 2 or brokn rice	15.30	59.82
Brewers' rice	6.28	3.78
Polish	8	16
Bran	20	40
Hulls	21.10	42.40
Total	162	162

This mill reports that during the milling season of 1898 Honduras rice averaged 85 pounds and Japan rice 95 pounds, total product from 162 pounds of paddy. The rice was below the average for other years.

Report of one of the largest mills in the United States.

Grades.	Best grade.	Medium grade.	Low grade.
	Pounds.	*Pounds.*	*Pounds.*
Head	70	55	30
Partly broken	15	20	25
Very broken	12	12	20
Brewers'	4	6	10
Total	101	93	85

Report of a mill having a daily capacity of 200 barrels.

Grades.	In best lot.	In poorest lot.
	Pounds.	*Pounds.*
Head rice	60	...
Slightly broken	30	60
Very broken	10	15
Bran	25	35
Polish	5	8
Hulls	32	44
Total	162	162

NOTE.—There is a difference in these reports; one mill shows the best and poorest grades, and the others the best and poorest special lots milled. Two of the mills show that in the poorest lots of rice milled there was no head rice and the third mill reports only 30 pounds in low-grade rice.

Mr. G. G. Bauer, manager of the Lake Charles Rice Milling Co., states that:

Aside from the larger percentage of head produced by the better class of rough rices, its value in the clean, on account of its superior quality, is much greater than that of head produced from medium or low grades. It is for this additional reason that fine rough rices always command such comparatively big prices.

The total loss by breakage in the United States approximates $2,000,000 annually. A large proportion of this can be saved by selecting better seed; by more careful attention to field management in the production of the crop, and by more care in curing and threshing.

RICE MILLING IN EUROPE.

The United States consul at Bremen, Hon. George Keenan, writes as follows in regard to rice milling in Germany:

Form and value of the rice imported.—Rice is never imported into Bremen in the form of paddy in the strict sense of that term. It is mainly imported in the husk form, broken and whole, uncleaned. It has the shell

on or part of it. It is in a similar condition to barley or oats taken from the thrasher, but often with less shell, depending upon the kind of rice. The Japan and Bengal rice has less shell when imported than the Siam or Burma, and this is one reason why the former commands higher prices than the latter. The cost price in Japan is stated at $2.40 per 100 pounds; in Bengal, at $2.16 to $2.40 per 100 pounds; in Siam, at $1.20 to $1.40 per 100 pounds; in Burma at $1.08 to $1.44 per 100 pounds. The cost price of course varies with the market and may be governed by the purchaser, the quantities and grades purchased, and the kind of connection the purchaser may have with the place of production.

Rice is always imported in sacks of about 100 pounds each. Freight rates from China to Bremen are $4.80 per ton by steamer; by sale, $1.92 to $2.16 per ton. The rates are governed largely by opportunity and competition in shipping. The largest concern in Bremen usually imports in its own vessels.

Cost of milling.— No reliable figures can be ascertained as to the cost of milling in Bremen. There are so many different grades of the paddy going to mill, and so many different grades of the milled rice produced, each at a different cost from the others, that detailed information regarding the whole would be necessary for an accurate conclusion. This it is impossible to get; at least the millers, if they know, are not disposed to impart the knowledge.

By-products.—The coarser part of the shell of the rice is used mainly for packing purposes. The finer part of the shell is cut up and mixed with the bran, and is used for cattle feed, as are the middlings or shorts. All of these by-products are consumed in Germany and sell, according to grade and quality, at from 22 cents to $1.40 per 100 pounds.

Work of the largest mills.—The largest mill in Bremen, which is said to be the largest of its kind in the world, uses engines of 800 to 900 horse-power, and 30 runs of stone; all of the shelling and grinding is done with the stone; the breaking or cracking of the rice (" skinning") is effected by steel rollers. The daily output of this mill, running twenty-four hours, is from 5,000 to 6,000 bags, each bag weighing, 110 pounds. The yearly capacity is 125,000 tons, 500 hands are employed, and there is a capital stock of $3,200.000. The wage rate is from 75 cents to $1 a day. From 250,000 to 300,000 sacks of the unmilled product are in store constantly.

There are three others—one with a yearly capacity of 70,000 tons, with $700,000 capital, and working 300 hands; one with a yearly capacity of of 40,000 tons, with $400,000 capital, and working 70 hands; the third about half the size of the last-named concern. Starch is the chief product of this mill, and the by-products are fed to cattle owned by the concern.

The total import into Bremen for the year 1896 was 412,834,237 pounds, valued at $5,534,282. The total export for the same period was 401,578.694 pounds, valued at $6,723.133. Freight rates from Bremen to New York on rice are—by steamer, $3,60 to $3.80 per ton; by sail, $1.08 to $1.20 per ton.

No intelligent information could be had concerning the number of pounds of whole rice, or broken, or fine broken rice passed through a No. 12 wire sieve. This point does not appear to have been estimated or measured by the millers here, at least they did not or could not give information concerning it.

As to the number of pounds of rice polish and rice bran obtained from 100 pounds of paddy and uncleaned, the estimate varies from 8 to 30 per cent, depending on the kind, quality, and condition of the rice, and also upon the degree of polish given it.

THE USES OF RICE.

RICE AS A FOOD.

As a food material rice is nutritious and easily digestable. In comparison with other grains it is poor in protein (albuminoids) and fat, and correspondingly rich in non-nitrogenous substances (carbohydrates).

RESULT OF ANALYSES.

Analyses show that 100 pounds of rice contains 87.6 pounds of total nutriment, consisting of 7.4 pounds protein, 0 4 pound fat, and 79.4 pounds carbohydrates. In comparison with this 100 pounds of wheat flour contains 87.5 pounds of total nutriment, consisting of 11 pounds protein, 1.1 pounds fat, and 74.9 pounds carbohydrates.[1]

The relative food values of rice and wheat, based solely on the amount of albuminoids they contain, are in the proportion of 10 to 19; based on the value of total nutritive material, the proportion is 87 to 82.54. The ease with which the deficiency of albuminoids and fats can be supplied from legumes and the almost absolute certainty of producing a crop every year are the principal reasons why rice is the staple food in many densely populated countries.

It is claimed that boiled rice is digestible in one hour, and hence is an admirable food for the last meal of the day. Rice should be at least three months old before it is used for food.

A SUBSTITUTE FOR POTATOES.

In rice-producing countries rice is used in the daily foods as a substitute for Irish potatoes and wheat bread. At every meal in oriental lands rice is the principal food. It is eaten alone with a little dried fish for seasoning. In well-to-do families bits of preserved ginger, beans boiled and preserved, with sauce, mushrooms, barley cake, and sweets are used as relishes with the rice. There is also generally a vegetable or fish soup with which boiled rice is eaten. In the rice districts of the United States rice is used in place of the Irish potato. Dyspeptics will find great relief in substituting boiled rice for potatoes. Rice polish, or flour, which is now sold at the mills at one-half to three-fourths of a cent per pound for cattle food, will when appreciated, be in demand for human food. It contains 10.95 per cent of protein, in comparison with 7.4 per cent for the clean rice.

BY-PRODUCTS OF RICE CULTURE.

STRAW.

Rice straw is worth preserving. As a fodder for stock its value is about equal to good southern prairie hay. Rice straw contains 4.72 per cent crude protein, 32.21 per cent carbohydrates, and 1.87 per cent fats. The sweetness and excellent flavor of well-preserved rice straw adds very materially to its practical feeding value, because stock will consume large quantities of it. Digestion experiments have not been made with the straw or any of the by-products of rice milling. Rice bran contains 12.1 per cent protein, 8.8 per cent fat, and 59.4 per cent fibre and carbohydrates; rice hulls, 3.6 per cent protein, 0.7 per cent fat, 35.7 per cent fibre, and 38.6 per cent other carbohydrates; and rice

[1] Fourth Ann. Rept. Conn. Storrs Agric. Exp. Station, 1891.

polish, 11.7 per cent protein, 7.3 per cent fat, and 64.3 per cent fibre and carbohydrates [1]

According to an estimate made by Dr. Stubbs, director of the Louisiana experiment station,[2] rice polish is worth $21 55 per ton; rice bran, $20.80; rice straw, $9.13; and rice hulls, $8.34. These values are taken assuming the same digestibility for the nutritive elements as for those contained in the by-products of wheat and other cereals.

HULLS.

It has been widely assumed that rice hulls have no practical feeding value. The usual practice of rice mills has been to burn them. It has ever been asserted that they were pure silicates. The analysis does not confirm this claim. One hundred pounds of air-dried hulls yield ash 13.85 per cent, fats 0 85 per cent, fibre 38.15 per cent, protein 2.80 per cent, and carbohydrates 34.99 per cent.

They are so deficient in flavor that it is difficult to induce animals to eat them. If ground and mixed with some highly nitrogenous food they could be used, but the small percentage of digestible material in them renders them almost valueless for food. It is evidently more economical to use them as a fertilizer. For this purpose rice hulls are more valuable than wheat or oat straw. While they have less nitrogen, for most soils the ash compensates. In all rice-producing countries it is important to increase the porosity of the soils and to add to the humus they contain, for general crops. Rice hulls should be ploughed under for this purpose

Hulls make an excellent mulch for garden and orchard, and in stiff and unfrosted soils are of great value when ploughed under in moderate quantities. The slow decomposition of hulls is here an advantage.

In oriental countries the hulls or husks are removed at home by passing the paddy rice through small burs made of clay, or cement, and wood, and are then used by the farmer as a fertilizer. The cost of removing the hulls is balanced by their value as a manure and the reduced cost for sacks and freight to market. The hulls form about 20 per cent of the weight of paddy rice. If the average costs of sacks and freight to market be estimated at one-fourth of a cent per pound, the saving by removing the hulls on the farm would be 2¼ cents per bushel or 8.1 cents per bushel (162 pounds).

HULL ASHES.

In passing through rice-milling districts large quantities of hull ashes will be noticed. These have been very little used by farmers and gardeners under the general impression that they were of no value. One hundred pounds of hull ashes contain 0.82 pound of phosphoric acid and 0.93 pound of potash. There are many other better sources of potash and prosphoric acid. The amount contained in the hull ashes would not pay the cost of scattering them over the fields.

Calling the mineral matter in the whole plant 100 per cent, we have, as shown by analysis:

[1] Yearbook U. S. Dept. Agriculture, 1896, p. 607.
[2] Louisiana Agr. Exp. Sta. Bul. 24.

Percentage of ash in whole plant.

Parts of plant.	Ash, per cent.
In the stubble and root	36.08
In the straw and leaves	36.08
In the hull	14.20
In the cotyledon and epidermis	11.07
In the clean rice	1.94
Total	1 0

Calling the mineral matter in the paddy 100 per cent we have:

Percentage of ash in paddy rice.

Parts of fruit.	Ash, per cent.
In the husk	51.01
In the cotyledon and epidermis	42.03
In the clean rice	6.96
Total	100

The planter who burns his straw and sells his rice in the paddy loses 63 92 per cent of the total mineral matter of the crop. If the rice straw and the hulls be returned to the soil as manure, 86.36 per cent of the mineral matter of the crop will be restored, and the loss would be only 13.64 per cent. The present method of burning rice hulls can not be too severely condemned, but doubtless will be continued as long as rice is sold in the paddy. Rice milling machinery is too expensive and too complicated to be successfully and profitably operated upon the farms. but hulling is a process requiring very simple and inexpensive machinery. It can be done profitably upon the farm, and is done in most of the great rice-producing countries. There is further advantage in removing the hull before shipment to market. Both the miller and the farmer can with greater exactness determine the quality of the grain. All uncertainty as to quality operates against the seller. Any broken rice resulting from the hulling would be retained and fed upon the farm. Chalky or sun-cracked grains, instead of decreasing the price of the entire crop, would generally break under the hulling process and be separated from the solid kernels, which would then sell for more than sufficient to compensate for any decrease in quantity. Such a system of marketing would require the planters to have good storage and do the hulling gradually through the year, as the product was required for milling. If the entire crop hulled should be placed upon the market at one time, as now, there would be great danger of destruction by the rice weevil while stored. The hard husk of paddy rice presents formidable difficulties to the attack of the weevil.

POMEGRANATE.

PUNICA GRANATUM.

BY J. U. LLOYD.

Botanical History.

The genus Punica consists at the present time of two species, the one under consideration and P. protopunica, described in 1882 by Balfour, from the Island of Socotra.

Punica granatum has been in cultivation from the earliest historical times, and is now found in all warm countries of the world, and frequently as an ornamental plant in this country and abroad, where it requiries protection during the winter season, as it will not endure the cold. It is recorded, e. g., that in 1838 the trees in the neighborhood of London were killed by the frost. The form generally grown as ornament is the double variety, and consequently barren. The fruit of the pomegranate has been esteemed a delicacy from the most ancient time, and we often see it offered for sale at our friut stands. In the West Indies, where the plant would thrive naturally, it is not extensively cultivated.

The pomegranate plant in the tropics reaches the height of a small tree 10 to 15 feet high. The leaves are opposite, are sometimes alternate above, oblong or lanceolate, thick and with entire margin. The flowers are bright-red and are clustered in the axis of the upper leaves. The calyx is thick, leathery, adnate, with five to seven thick valvate sepals. The stamens are numerous, inserted in the calyx tube. The petals are normally the same number as the segments of the calyx and inserted in the mouth of the calyx-tube alternate with its segments. In the double flowers commonly cultivated the petals are of course indefinitely increased by transformation of the stamens. The fruit, which has been prized for the pulp in which the seeds are imbedded, is about the size of an apple,* smooth, with a thick skin, and is in reality the enlarged calyx surmounted by its persistent lobes. It is divided by thin divisions into a number of cells, each packed full of angular seeds contained in a juicy pulp.

HISTORICAL NOTES.

The pomegranate shrub, according to DeCandolle, is originally a native of Persia and adjacent countries, but has been cultivated and naturalized in the Mediterranean countries at such an early date that it has ever been considered indigenous to these countries.

Pomegranate was included among the vegetables that were held sacred by the Assyrians and the Egyptians, and the latter nation made it a custom to place in the graves of the dead, fruits of the field and garden, among them pomegranates, specimens of which are preserved to the present day. The pomegranate had undoubtedly an occult significance with the ancient nations. It was frequently used as a mystical emblem in adorning the capitals of Assyrian and Egyptian columns, and the Bible tells us that in the building of Solomon's temple the capitals of the columns were decorated with a "net-work of pomegranate." Also the hem of the high-priest's robe was adorned with imitations of

* Called by Pliny malum punicum (Punic or Carthaginian apple).

pomegranates in blue, purple and scarlet, alternating with bells of gold. The promegranate was one of the three fruits brought to Moses by the men that he sent to spy out the land of promise. Many other passages scattered throughout the Bible refer to our plant, and testify to the esteem in which the tree and the fruit (then called rimmon) were held in ancient times. The fruit and seed of the pomegranate are mentioned in the "Arabian Nights.

Pomegranates were represented on Carthaginian and Phenician medals and on the reverse of the coins of the island of Rhodes. In Greek mythology the pomegranate is very conspicuous and symbolizes fecundity and abundance. The fruit was dedicated to Juno, a deity always represented in sculptures as holding a pomegranate.

The Greek authors, e. g., Theophrastus, describe the pomegranate under the names of "roa" and "roa side"; also Dioscorides, who quite explicitly sets forth the medicinal properties of the different parts of the plant. Among Roman authors who describe the pomegranate and its uses are Cato Censorius, Pliny, Celsus, and others. Subsequent writers, for example the Arabians, in the ninth century, also refer to the pomegranate, but seem to have mainly reiterated the substance of the writings of their Greek and Roman predecessors. Of the writers of the middle ages may be mentioned Tragus and J. Bauhinus, the latter giving a most detailed compilation of that which was known before his time on the subject of the pomegranate, including the myths with which it is connected. It was not until the present century, however, that the literature of the pomegranate was enriched by the study of its chemical aspects.

CONSTITUENTS AND PROPERTIES.

The bark of the root, according to Wackenroder (1824), contains 22 per cent (according to a later authority, in 1880, 20 per cent) of a tannic acid,, subsequently termed punicotannic acid. The astringency of the root is due to this principle and the aqueous infusion yields a dark-blue colour or precipitate with ferric salts. In 1878 and 1880 Tanret discovered several alkaloids in the root-bark, the most prominent of which he called pelletierine. This has been shown to possess the anthelmintic properties of the root. The amount of alkaloids in the root-bark seem to vary according to the variety of flowers, the white-flowering variety, occurring in Java, yielding as high as 3.75 per cent of hydrochlorids of total alkaloids. The bark also contains mannite and a yellow colouring matter. A yellow stain is produced if the inner surface of the root-bark is moistened with water and rubbed on paper.

The rind of the fruit also contains a considerable amount of tannc acid, about 19 per cent. It is stated that the rind of the fruit of the wild pomegranate is more astringent than that of the cultivated.

Pomegranate flowers called balaustion by Dioscorides, also are rich in tannic acid, have a bitterish and astringent taste, but no odour. They colour the saliva violet-red.

USES.

For Tanning.—Pliny mentions that the rind of the sour variety of pomegranate was used as a tanning material.*

* Hence the name "malicorium," from corium, Latin for leather. Another official name of the rind has been cortex psidii.

Shortly after the days of Pliny the Moors introduced tanning into Spain, and their finest moroccos were tanned with the rind of this fruit. Tanning in this manner is still in vogue in some countries, e g., Tunis, where the pomegranate abounds; also in Japan.

For Dyeing.—The rind of the pomegranate, especially that of the wild plant, has been used in India as a dye-stuff from ancient times. Alexander Burnes, in his travels, describes "a little yellow flower," called Esbaruk, which grows in the low hills near Karshi and Balkh (in Afghanistan), and says that it is used as a dye-stuff He incidentally remarks that it produces a better colour than the root of the pomegranates. Balaustion flowers are stated by Pliny to be used for dyeing cloth.

As an article of Food.—The refreshing and cooling taste of the pulp of this fruit gave the plant great favor with the ancient natives of oriental countries, and also in our age the pomegranate is sometimes used as a table fruit. The opinion of its excellence, however, is not by any means shared universally. Pickering states that in his experience the best pomegranates are found in Mascat in Arabia. From this province the fruit is frequently imported into India. Wine frequently was made from the pomegranate in Palestine, as evidenced from the biblical name "gath rimmon," meaning press of the pomegranate, and in Persia where whole woods of pomegranates are to be found. The art o making wine from this source was raised to the importance of a nationa l industry.

As a Tenifuge.—Charaka-Samhita probably the oldest medical work in the world, in its translation does not mention the bark of either the tree or the root of pomegranate and does not mention it in connection with tenicides.* The anthelmintic properties of the root and rind, however, were well known to the ancient people of more proximate historical age. Newberry quotes from a description on the "Papyrus Ebers," discovered in recent times, on which is found the following passage: "To drive away the worm: Make an infusion of the rind of pomegranate." The Chinese also were acquainted with the anthelmintic property of the root. Among the Roman authors, some as e g. Cato Censorius and Pliny, recommend the fruit rind; others, e .g Celsus, the bark of the root as an efficient vermifuge. The Arabian writers maintain that the root-bark is a perfect specific for tapeworm.

Constantinus Africanus, a prominent physician of the Salernian school of medicine, is quoted by Tragus as follows: "Boil the peelings of pomegranate in wine, and drink this potion; it will kill all the worms, especially the kind called 'ascarides' and it is the peculiar property and nature of the pomegranate to kill worms. This virtue of the plant, curiously enough, afterwards seems to have been entirely overlooked by the medical profession, and slumbered until the beginning of this century.

In 1807, Dr Buchanan, an english physician in India, announced to Europe the fact that in India, from time immemorial, the root of the pomegranate tree was used against tapeworm with miraculous success. He cited successful cases from his own practice and that of others: "I have seen two species of tenia expelled by this medicine; one is solium,

* However the work of translation is not yet complete.

the other not yet described.*" The correctness of these statements was subsequently borne out by the testimony of various eminent physicians. Dr. Gomez of Lisbon successfully treated fourteen persons for tapeworm in 1822, and the results were afterwards published in France by Merat. The latter publication seems to have contributed largely to spread the use of this drug as a remedy for tapeworm throughout Europe. In England, however, pomegranate, it seems, has not as yet replaced the male-fern. In India the drug is now considered the sovereign remedy for tenia as various writers testify.

In this connection it may be of interest to state that in India the pomegranate root-bark is seldom met with in the shops As few gardens are without the plant, it is freshly dug when required. Royle and others maintained that the dry bark seems not to contain any definite tenicide principles, but De Vrij brought evidence to the contrary. However, the alkaloid pelletierine was tried as a tenifuge with much success and is now extensively employed in the form of a tannate.

The balaustion flowers possess no tenifuge property. Merat and De Lens state that accordimg to Cullen the rind of the fruit has less vermifuge power than the bark of the root, which statement is supported by the evidence of physicians for whom the writer has prepared the remedy.

Other uses in Medicine.—The pomegranate, besides being used as a vermifuge, is employed, although more rarely, for other medicinal purposes, e.g., for arresting hemorrhage and healing ulcers. Charaka-Samhita gives the fruit (rind?) a position as an astringent (p. 15 and 33) in diarrhœa. Two varieties are described (p. 357), both being known under the name "dadima." In modern India, a decoction of pomegranate rind is used in combination with aromatics and opium for diarrhœa, and a decoction of the root is said to be useful in the advanced stage of dysentery. The ancient writers, as Dioscorides and Pliny indicate numerous uses in medicine for the various parts and the several species of the pomegranate, some passages furnishing rather curious reading matter, which, however, we cannot find space to repeat.

PHARMACOPEIAL RECORD.

The antiquity of the plant explains the fact that the drug found a place in early pharmacopeias. The Pharmacopœia Borussica of 1829 (5th edition) recognized granatum, cortex pomi and flores balaustiae. In the 6th edition of 1846, however, we find only cortex radicis granati. This was extended in the 1882 edition to cortex graniti, which meant the bark of the plant and that of the root. The balaustion flowers, usually collected from the double variety, were still official in 1844 in the Dublin Pharmacopeia.

As regards the United State Pharmacopeia, granatum was first recognized in 1830, the Philadelphia edition introducing the rind of the fruit, the New York edition the bark of the root. The subsequent editions carried both, until in 1880 the rind of the fruit was dropped. In the 1890 edition the stem-bark was added.

* For a list of references in this direction. See Mérat & DeLens (14.)

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[Issued 23rd July, 1900.]

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BOTANICAL DEPARTMENT.

New Series.] AUGUST, 1900. Vol. VII. Part VIII.

WATER IN SOME OF ITS RELATIONS TO AGRICULTURE.

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Every person in any way connected with Agriculture will readily admit the importance of the subject of this article. The subject of the water supply intrudes itself forcibly enough upon the English farmer, but the planter in tropical countries has to give it far more serious consideration. The former has to busy himself more often with getting rid of superfluous water *i.e.*, drainage, than with the difficulties of getting sufficient water for the needs of his farm. On the other hand in many parts of the tropics, agriculture would be absolutely impossible without an artificial water supply. But this article is not concerned solely with irrigation; it is intended to be rather a general survey of the various ways in which water is connected with the production of crops.

The fact that many plants are found on analysis to contain as much as 90 per cent. of moisture at once suggests some of these connections It will be as well to enquire first, what is the duty of this large proportion of water? Secondly, how does the plant obtain it? and thirdly, how can the agriculturist help the plant to obtain its water supply?

Although it seems natural that the subject should be presented in this succession, that is, that the consideration of the demand and the reasons for it should precede that of the mode of supplying it, it will perhaps be found convenient for the purposes of this article to discuss first the supply and then the way in which this supply is utilised. We shall then first take up the subject of the water in the soil, how it is obtained and how preserved, devoting the second part of the article to the relation of the plant to water.

1. *Water in the soil.* There are two questions to be considered :—1st how does the soil get its moisture, and secondly, how can this soil moisture be conserved.

Of the natural method of water supply little need be said, for it is not much that the agriculturist can do to increase or diminish the rainfall. It is however in the choosing of a plantation that that subject must receive close and careful consideration.

Although it has been said that the agriculturist can do little to increase the rainfall, he has considerably more power in his hands than

he is usually aware. In Jamaica very little importance seems to be attached to the subject of forestry, or more especially the influence of trees on the natural water supply and the conservation of soil moisture. It is usually vaguely understood that the rainfall is greater in well wooded districts than on open tracts, but the fact that the mere planting of a fringe or belt of trees—known as a "wind-break"—is instrumental in saving a large amount of soil water by preventing evaporation, is seldom properly appreciated.

The subject of the artificial supply of water for *irrigation* is too wide to be more than just touched upon here It is slowly being realised that it is not necessarily *only* the dry rainless districts that require to be irrigated. For irrigation if practised with reason and intelligence enables the planter to do what the natural rainfall may often fail to accomplish—that is, supply the crops with sufficient water *at the right time.*

If, however, the land is irrigated without due regard to the requirements of the individual crop, not only will there be a great waste of water but also, in all probability, considerable damage done to the soil. Further, irrigation must not be overdone.

Over irrigation will result in :—(i.) *The loss of much available plant food* which will be washed out of the soil. The water will dissolve much more of the soluble salts than the crop is capable of absorbing. Naturally the most soluble salts will be washed out in the largest quantity, and it is for this reason that an over-irrigated soil is so easily robbed of its nitrates—so valuable on account of their being the source of the plant nitrogen.

(ii.) *Over-cropping,* which will permanently damage the soil unless proper return be made by means of fertilizers. The growth of the crop is so rapid that the process of converting dormant into active plant food is unable to keep pace with it.

(iii.) *Coldness of the soil.*—A certain amount of heat will not increase the temperature of a given bulk of water to the same extent as it will an equal bulk of soil, consequently a wet soil requires more heat to warm it than a dry soil -in other words—the wetter the soil the colder. Germination is often retarded by the coldness of a soil.

(iv.) *Stagnation and consequent sourness.*—It must be borne in mind that no land should be irrigated unless properly drained, either naturally, or by means of pipes or ditches. The irrigation of undrained land would most certainly lead to the badly ventilated condition of the land such as is found in water logged soils.

The *drainage* of a soil must always be closely connected with the water supply, although the existing climatic and geological conditions tend to lessen its importance in Jamaica.

The impetus lately given to banana cultivation by the establishment of the Direct Fruit Line must mean that more and more land will be brought under irrigation, and consequently the practical agriculturist will find himself face to face with the necessity for *drainage.*

The chief object of drainage is to aërate the soil, and any operation that helps to ventilate the soil must increase its fertility. In a water-logged soil all the interspaces are filled with water to the exclusion of air, with the result that the plant-roots rot, owing to being deprived of the necessary supply of oxygen.

This absence of oxygen in the soil will cause also a cessation of the various processes by which dormant plant food is converted into an active and available form; for many changes due to the action of bacteria—such as nitrification—are dependent upon the supply of oxygen. Not only does this filling up of the air spaces in the soil prevent the entrance of oxygen but also prevents the escape of carbonic acid gas and other deleterious substances. Such an undesirable state of affairs can be remedied by draining, because as the water drains downward, room is made for fresh air to enter and occupy the spaces between the soil particles. It is for such reasons as these that agriculturists are warned against over irrigation and the consequent badly ventilated condition of the soil.

Having considered the first question, viz.: How does the soil get its water? we can pass on to the consideration of the manner in which the water is held in the soil, a knowledge of which should place the agriculturist at an advantage in his endeavour to control his water supply. As the suitability of a soil for agricultural purposes depends largely upon its power of holding sufficient water to supply the needs of the plant, it becomes one of the chief aims of the cultivator to improve this power and to prevent unnecessary loss of water. An answer to the second question will be more readily obtained, if it be remembered that owing to the irregularity in the shape of the soil particles, there are small interspaces which are filled either with air or with water. When a quantity of soil is completely saturated with water all these interspaces are occupied by water, on the other hand if the soil is perfectly dry these interspaces are full of air. It is the amount of water that a soil is capable of holding when saturated that determines its *water holding capacity.* This capacity can be readily estimated by a simple experiment.

Take an ordinary glass jar with a fairly narrow neck Knock the bottom out. Fasten up the jar with the neck downwards, putting a glass underneath to catch the drainage water. Block up the neck of the jar with broken earthenware, covered by a layer of pebbles This will ensure perfect drainage. Fill up the jar carefully and evenly with a known weight—say 1lb—of dry soil, leaving a space of about 2 inches at the top Pour on a known volume of water—say one pint at a time—at regular intervals, measuring the amount that drains through each time. This amount will gradually increase until the whole volume of water poured on at any one time will pass through. The difference between the total volume of water poured on and the total volume of the drainage gives the amount of water that one pound of dry soil is capable of holding. In this way the water holding capacity of soils of different kinds can be compared, and the value of the methods of increasing this power experimentally tested.

Although the amount of water that a soil can hold when saturated will depend upon the volume of the interspaces, this is not the factor that determines the amount of water *permanently* retained by a soil. This amount is regulated by the *fineness of the particles.*

The reason of this will not be apparent. It will be necessary to examine more closely into the way in which the soil holds its water. The water forms films round each individual soil particle and if the soil is fairly dry the films will necessarily be very thin, getting thicker and thicker

as the wetness of the soil increases. Bearing this fact in mind it will be more easily understood how it is that the fineness of the soil influences the capacity of a soil for retaining moisture. In other words, the finer the soil the more particles, and the more particles the more films of water. This is what is meant by saying that the amonnt of water permanently held by a soil is determined by the amount of surface exposed by the particles, *i.e.*, the extent of the internal surface. It follows then that gravel and coarse sand will be the soils that retain least water, while most will be retained by fine silts and clay.

There is however one other factor influencing this property of the soil and that is the *porosity of the individual particles*. It is quite evident that a soil will be able to hold all the more water if its particles are themselves porous, as in the case of chalk and humus. Here then we have one of the many reasons why the addition of animal or vegetable matter improves the soil. Soils rich in humus are much better able to withstand prolonged drought than those poor in this constituent, because they are able both to absorb more water and also to hold it more firmly. A soil that has long been cropped without any return in the form of humus will be found to have lost much of its water-holding capacity. The fertility of a poor sandy soil can be appreciably improved by ploughing in green crops, such as the velvet bean or other leguminous plants, or by a liberal application of stable manure.

As it is our aim to see how the agriculturist can keep the moisture in his soil, it is necessary to consider the question of the movements of water in soils which result in the loss of soil water. There are three chief ways in which the soil loses water (i) by percolation (ii) by evaporation (iii) by the transpiration of plants.

(i.) *Percolation*. This process is the natural sinking of water in the soil due to the porosity of the latter. The surface soil is perfectly saturated only after heavy rain; for as soon as the rain ceases, water commences to *sink* owing to the ordinary action of gravity. The films of water around the particles at the surface get thinner and thinner, while an increasing number of the dry particles below becomes surrounded by the films, the water distributing itself by passing from one particle to the next. The water that sinks down in this way may be permanently lost to the crop by draining right away through cracks and crevices in the rock to the streams and rivers, or it may simply sink down till it meets an impervious bed in the subsoil and there remain to be brought up again for the use of the crop in a manner that will be discussed later. The former case needs serious consideration, for not only does it rob the soil of water but also of a large amount of soluble and active plant food. Every film of water will have dissolved a little plant food from the soil particle with which it was in contact, consequently each drop of water that escapes by drainage will take away with it a little soluble plant food. Let us consider the case of the sinking of lime as an istnance.

Many intelligent practical agriculturists are inclined to scoff, when told their lands want liming, and exclaim that that is absurd because the soil rests on a limestone formation. They do not realise that it is quite possible to have a soil deficient in lime resting on a limestone formation. This is often unstisfactorily explained by the statement that lime sinks. But this movement is not peculiar to the

salts of lime. The water percolating downwards will carry with it anything it can dissolve.

It is in this way that rain water (containing carbonic acid gas) is able to dissolve limestone and in time wash it out entirely from the surface soil. There will be a similar movement of all other salts that are at all soluble in water.

What then can the cultivator do to check this loss by percolation. He must remember that it is not in a stiff clay soil that he need fear losses of this kind but in a loose open sandy soil.

His object then must be to diminish the porosity of such a soil. This he can do either by compacting the soil with a roller or by binding the soil by the addition of humus or clay.

It is now left to consider the case of the water that has not escaped beyond the subsoil, and it is this water which is subject to the second mode of loss, *i.e.* by

(ii.) *Evaporation.* It must not be imagined that this process ceases when, after the wetting of a soil by rain the dry air has caused the surface soil to lose its water by evaporation.

Evaporation of the water in the surface soil will cause the water in the subsoil to assume an upward motion. We have seen that water sinks by passing from particle to particle, it can also rise in a similar manner. As it was the action of gravity that caused water to sink, what force is there to cause it to rise against the action of gravity? The force is called *surface attraction.*

It must be remembered that though this force brings water up to the surface of the soil, this is not the reason for the expression "surface attraction." The word surface in this case refers only to the surface of each soil particle.

Let the reader illustrate this action for himself by means of a simple experiment.

Place two flat pieces of glass (say 1″ by 3″) together so that they *almost* touch, and dip their edges to the depth of about ¼″ into a tumbler full of water coloured with red ink. It will be observed that the water will rise *between* the two surfaces to the height of an inch or two. This rise of the water is due to surface attraction. The surface of the glass attracting the water with a force sufficient to overcome that of gravity acting in an opposite direction. In the same way the surface of each soil particle is capable of attracting to itself water which will form a film around it, causing the water to pass upwards from particle to particle. Now the finer the particles are and the closer together the more water will pass upwards, because the greater the number of particles the more surface there will be to exert this attractive force The closeness of the particles also assists in this movement, in that there will be a shorter space for the water to pass, springing as it were from particle to particle. These then are the points which enable us to control to some extent the water supply. First of all this upward movement must be encouraged, because a supply of water and dissolved plant food that would otherwise have been beyond the reach of the plant roots, is thereby obtained It must not however be allowed to come right up to the surface, for then the water will be lost to the plant by evaporation, and also the dissolved matter will be precipitated *out of reach* of the roots. How can this be avoided? By bearing in

mind one of the points just mentioned, viz.: that the upward movement is more active when the particles are closely packed. It follows then that the simple operation of loosening the surface soil with hoe or fork to the depth of a few inches will stop the water from rising higher than just where the plant roots are situated below the surface of the ground, and check loss by evaporation. This loss can also be prevented by protecting the surface soil from the rays of the sun by means of a mulch of leaves or trash. The surface soil being thereby kept cool, evaporation is checked. Both of these methods are applicable in the case of a tree plantation, such as an orange grove.

If a circle with a radius of about 3 feet be marked around the tree, the enclosed surface soil may be scratched up and a layer of trash be placed around the base of the stem as well, a considerable amount of water will be saved for the use of the plant.

Further, as the wind is such a powerful factor in causing evaporation, any method which will prevent the wind from blowing across cultivated land, will tend to decrease the loss by evaporation. This saving of soil moisture may be secured, as has already been mentioned, by the planting of wind breaks.

The reader can verify some of the above statements for himself in the following manner:—

Pack long glass cylinders full of *dry* soils of different kinds and invert them in soup-plates of water. Note the different heights to which the water rises in each case, and also the effects of loosening the top layers or of changing the texture of soils by the addition of clay, sand, humus, &c.

(iii.) *Transpiration*. The method of this process will be discussed under the heading of 'water in the plant.' It is the method by which the plant breathes out through the pores of the leaves its excess of moisture. Remembering that for every pound of dry matter added to the weight of a plant, about 300 pounds of water have to be taken in at the roots, it will be realised what a large amount of water is removed from the soil by the plants. The loss of water in this manner cannot be controlled as can the losses by percolation and evaporation; this process must in fact be considered to be on the whole advantageous. Yet we can reduce the loss by clean cultivation, *i.e*, by allowing only those plants which we are cultivating to take water from the soil. The keeping down of weeds in a crop will therefore be the means of preventing the loss not only of plant food but also of soil moisture. The constant use of the hoe is to be advocated for this reason among many others.

These few remarks upon the relation of the soil to water may serve to *indicate* the lines upon which success in the matter of conserving soil moisture may be expected. It will be readily admitted that under conditions such as those that exist in Jamaica, any operation that may assist in this, to however slight an extent, is worthy of the agriculturists' attention.

2. *Water in the plants*.—No practical agriculturist requires to be told that an adequate supply of water is absolutely necessary for the healthy growth of the plant. To arrive at the reasons for this necessity, the part played by water in the life history of the plant must be considered.

Water assists the feeding of the plant in supplying it with the two elements of which it is composed, viz.: hydrogen and oxygen, which are necessary for the building up of certain carbon compounds such as starch and sugar, and secondly in acting as a vehicle by which the other forms of plant food are distributed throughout the plant. The importance of the work done by water in the second place will be realised if it is remembered that with the exception of the carbonic acid gas passing in from the air through the leaves, all the substances that go to build up the plant enter it through the roots. Further nothing can pass in through the roots that is not in solution and in fact in a very dilute solution. It follows then that the plant is dependent upon the water in the soil for the whole of its food constituents except carbon.

Very few soils are so poor in available plant food that they cannot support plant life if they have a sufficient water supply. That surely justifie sus in considering that the conservation of soil moisture should receive the utmost attention from the planter.

The necessity for moisture springs up simultaneously with the actual birth of the plant. For the very first process in the plant's life history, the change from the dormant to the living state, which is called germination—can only take place if the seed is supplied with water. As the seed ripens it parts with almost the whole of its water thereby rendering the protoplasm of the individual cells inactive. For this complex substance, giving to every cell of the plant what we know as 'life,' can exhibit none of its vital activities in the absence of a constant supply of water. This explains why the seed is able to lie dormant until it obtains sufficient moisture to re-awaken the slumbering protoplasm. The next thing the water has to do for the plant is to dissolve the food stored up in the seed and bring it into a condition suited to the requirements of the young plant or embryo. It is, too, the absorption of water that causes the seed to swell up and burst its case, thereby allowing the young plant to make its way out. As soon as the food store has been consumed, the young plant has to commence absorbing its food in a crude form from the soil. Water then has to dissolve from the soil salts containing the following elements:—nitrogen, sulphur, phosphorus, calcium, potassium, magnesium and iron. The other elements required by the plant for food are hydrogen, oxygen and carbon, of these the carbon is obtained, as has been mentioned, from the carbonic acid gas of the air, while the other two are got by splitting up the water itself into its two component elements. Thus with the aid of water the leaves receive a supply of all these elements and manufacture them up into the complex organic substances of which the plant is composed This passage of water up from the roots to the leaves may be seen by placing a young plantlet whose roots have been freed from soil in a saucer of water dyed blue with aniline. After some time the veins of the leaves will be found to be stained.

Of this large amount of water that passes up into the leaves only a comparatively small proportion is actually required as food, the bulk of it being got rid of by the process of *transpiration*.

The solution which passes in through the plant root must be very dilute. Some idea of the weakness of this solution will be obtained by bearing in mind what has already been said about the large proportion

of water necessary to add one pound to the weight of the dry matter in a plant. It will therefore be readily understood that a great concentration must take place before the dissolved matter can be utlised. This concentration takes place in the leaves. Drops of pure water ooze through the tiny pores, or *stomata*, on the leaves and are then evaporated. The stomata are so made that they can regulate the amount of water that is transpired. When there is a liberal supply of water passing up to the leaves the two 'guard cells,' which by reason of their concave shape form the opening, become turgid. This causes them to become still more concave, thus increasing the size of the opening. More water is in consequence able to pass out. If on the other hand the plant is becoming dry, these cells collapse closing the opening. The amount of water transpired is thereby very much diminished. This function is such an important one that there is an intimate connection between the form of the leaf and and the amount of transpiration required.

Take examples of plants grown under very different conditions—the banana growing in moist situations, requiring a large supply of water, and the cactus plants which grow in dry sandy places and seem to require no water at all. What is the difference in the form of the leaf? The huge leaf of the banana increases the number of the stomata to such an extent that the plant is able to get rid of an enormous amount of water, while the leaf of the catcus has almost entirely disappeared in order that the number of the stomata may be so reduced as to check transpiration.

A simple experiment will prove that this process takes place. Cover two tumblers partially filled with water with post cards through each of which a small hole has been bored. Through the hole in each card insert a fresh green twig, seeing that it fits tightly and dips into the water. Cover each twig with another tumbler, clean and dry. One pair of tumblers should now be placed in the sunlight and the other in a dark corner. If these are examined after a few minutes, it will be found that the upper tumblers are dim with moisture. This dimness will be apparent to a very much greater extent in the case of the one that has been exposed to the sunlight. This experiment proves not only that plants transpire, or give off water vapour, but also that this action takes place much more quickly in the sunlight.

If it were not that plants lose water by transpiration, cuttings, budwood, &c., might be kept for any length of time without withering. It is owing to this work of the leaves that it is found necessary to divest the budwood of all its leaves before proceeding to cut out buds, in order that its moisture may be preserved.

Normal transpiration is beneficial to the plant because it helps to cause the *upward* flow of the sap. As soon as it becomes excessive, however, as in times of drought, the plant begins to suffer. As soon as the amount of water transpired is in excess of what passes in at the roots, the leaves will wither.

The amount of water contained in a plant varies considerably with the kind of plant, and, in the same plant, with the period of growth. Further, some parts of the same plant contain more water than other parts, e.g. the average amount of water in a plant is from 60 to 80 per cent, but the percentage in a ripe fruit is considerably higher,

and in a dry seed far less, than the average. The moisture in a plant is easily estimated by weighing out a portion of the plant, drying at a temperature of 212° F. for about half an hour, and weighing again when cool. The decrease in weight gives the loss in drying, or the amount of moisture.

In conclusion, a word or two might be said as to the effect on the plant of an unfavourable water supply. As was stated when dealing with irrigation, an excess of moisture in the soil means the absence of oxygen and the consequent rotting of the root Seeds are often prevented from germinating by a similar state of affairs. It should also be borne in mind that the plant does not require the same amount of water the whole year round. In the growing season it will naturally require more than when passing through the resting stage.
A careful study of the life and habits of the plant must greatly assist the cultivator in his endeavour to obtain the largest return for the smallest outlay.

Although this article is styled "Water in some of its relations to agriculture," but a few of these important relations have been considered. The many other relations such as the effect of water in the formation of soils, the uses of water on an estate, both for purposes of power and of cleansing, and the supply for stock are far too important to be lightly passed over at the end of an article.

WASHING COCOA.

Mr. S. H. Davies who has been for some time engaged in making chemical experiments on Cocoa, etc., for Messrs. Rowntree, writes as follows :—

"My reply to your questions concerning the advantages of washing Cocoa would be :—(1) The loss of weight is appreciable and might amount to 2 or 3 per cent., a serious item when dealing with large quantities of Cocoa. (2) Washing renders the Cocoa more friable. (3) If the brokers are accustomed to Jamaican Cocoa with a certain appearance, they will resent any change; they are conservative and have many strange conventions about the appearance of Cocoa. (4) Removal of the pulp by washing will not greatly reduce the time of drying.

"On the whole I should advise against washing cocoa. All this applies to a properly fermented Cocoa, not to the native dried stuff."

AN OPEN LETTER TO A SMALL CULTIVATOR OF COCOA.

VARIETIES OF COCOA.

Dear Titus,

What an extraordin ary vareiety there is, both of shape and colour, in the pods growing on your "chocolate" trees. Those short, fat, smooth skinned pods are called *Calabacillo* cocoa by the Spaniards; the big, heavy, broad-shouldered and straight pods with a rough skin are the *Forastero* kind, or Trinidad cocoa, and the long curved pods, constricted at the upper end, tapering at the lower end, with a deeply wrinkled skin are the *Criollo* variety. Each may be again divided into red or yellow, mottled or buff, thin skinned or thick skinned.

Even then we shall not have exhausted the shapes and colours of pods in your cocoa patch because most of your trees are hybrids and cannot be said to belong entirely to anyone of the three chief varieties named above. Still you could distinguish roughly from the appearance of the pod, more accurately, however, from its contents, to which variety a given tree is most nearly akin.

Thus a *Calabacillo* tree gives pods containing little beans. deep purple, greyish purple or even slate coloured, having a disagreeable, bitter, woody flavour; the *Forastero* gives big beans of a pink or pale purple tint, while the true *Criollo* yields plump white beans of a sweetish pleasant taste.

The Calabacillo cocoa is the least valuable variety and should never be planted. With the means at your disposal, you will be unable to remove that bitter flavour so that the chocolate manufacturer cannot use these beans for his finer confections and you cannot obtain a good price for them. You will probably find too many Calabacillo trees in your cultivation, your blend requires sweetening with an admixture of the other two kinds, especially the Criollo, or white bean. When planting, cut open one bean from each of the selected pods—if it is white or pale pink in colour, plant the remaining beans.

I assure you, Titus, you and your children will bless me for this advice.

PLANTING.

If you have a chance of planting on a slope giving shelter from the prevailing winds by all means do so. If not, a line of rose-apple or some form of wind belt should be established.

I beg you will not follow the example of your neighbours and plant too closely. When the trees are fully grown the space should allow of free circulation of air. A good distance is 15 feet in deep soil; in poorer soil when the trees are not likely to attain any great size 12 feet is the closest permissable; if your soil is bad, don't plant cocoa at all.

PRUNING.

I see you are trimming your trees so as to keep them low and bushy. I should advise that you should not heavily prune the top branches. By all means cut off branches which are growing downwards A plan followed in Trinidad and elsewhere is to allow three main branches to grow and then, if the tree requires balancing, allow too shoots to grow higher up on the lightest branch so as to form a second three-prong arrangement. You will then carefully lop off all "gourmandisers" and suckers that make their appearance.

Pruning is so all important that you will doubtless attend to it yourself A young tree is soon ruined by indiscriminate slashing with a cutlass.

PICKING.

As a careful man, Titus, you always use a cocoa knife to cut off your pods, but there are still many Jamaicans who deliberately wrench the pod from the tree by hand, leaving a wound which takes long to heal and destroying all chance of fresh blossom forming on the spot.

This is the greatest crime in the cocoa planters calendar.

SWEATING.

Accumulate at least 500 pods before breaking.

You will get better results by curing larger quantities. 2,000 to 4,000 pods is a convenient quantity. Black pods should be broken

separately, the contents dried directly in the sun and put aside as inferior cocoa.

For the clean contents I should recommended the following "sweating" process.

A simple box is made one foot deep and varying in length and width according to the quantity of cocoa. Thus the contents of 1,000 pods require a box 2 ft. 6 in. long, 2ft. wide and 1 ft. deep (inside measurements) and will fill such a box to a depth of 9 in.

It must be constructed so that no iron nails come in contact with the cocoa, for iron is attacked by the "sweatings" forming a black liquor which discolours the cocoa.

The bottom of the box is bored with many holes, it is raised from the ground on two blocks of wood. It should be under cover and in a clean place free from dust. No lid is required.

After filling with cocoa, cover with a piece of clean sacking. Each morning turn up the whole mass with the hands; the cocoa which was at the sides and bottom being now towards the centre. If the quantity is small, turn out to dry on the fifth day, if larger (say, over 2,000 pods) on the sixth day, i e, after five full days' "sweating." Scrub out the box thoroughly, wash and dry the sacking before beginning a fresh batch. Thus by a short fermentation of a shallow mass, with plentiful access of air, you will get better results than by keeping the mass closely packed together in a deeper vessel. You may not believe me, Titus, but the close packing of the mass does not make it hotter; on the contrary the more air reaches the mass, up to a certain limit, the hotter the cocoa will become.

As prices stand at present you will not find it advisable to ferment for a longer time, but on the other hand I cannot recommend you to shorten the time by a single day as your cocoa would then retain too much of its original bitter flavour.

DRYING.

To obtain a good colour and appearance you should not let the cocoa dry too rapidly during the first day. Thus if you have turned out your cocoa from the box in the early morning (it should never be turned out at any other time), keep turning it over continually and, if the sun's heat is intense, cover your cocoa from noon to 2 o'clock, then expose again until evening.

Next morning, at sunrise, rub the cocoa well by hand, or dance it with the feet, until you get a uniform glossy appearance, spread it out and allow to dry on successive days until the bean breaks readily between the fingers.

Hoping that your autumn crop will prove as large as the plentiful blossom indicates.

Yours, S. H. D.

*NATURE STUDY IN RURAL SCHOOLS.

Everyone who is familiar with the work of our Education Department knows that the Inspectors are given explicit instructions to discountenance the unintelligent teaching of science, and to do everything in their power to encourage the observation and study of natural

* Nature, April 5, 1900.

objects and phenomena. The "object lessons," which are given in the lower standards, are intended to lead the pupils to use their eyes and compare one thing with another; and though they have become in some schools of too detailed a character to develop the faculties of observation and reasoning, the fault is chiefly due to the fact that many teachers are not observers of nature themselves, and are therefore unable to describe natural things except in the language of the text-book. Every effort has, however, been made by the Education Department to show teachers that this is not the kind of teaching intended to be given as object lessons. Several circulars have been issued containing instructions as to what should be done, and the new Board of Education has shown sympathy with the work of arousing interest in nature by issuing a circular, from which the following extracts have been taken, to managers and teachers of rural elementary schools. The issue of this document by Sir G. W. Kekewich at the very commencement of the work of the Board of which he is the secretary, may, we trust, be taken as an indication that increased attention is to be given to the teaching of scientific subjects in elementary schools:—

The Board would deprecate the idea of giving in rural elementary schools any professional training in practical agriculture, but they think that teachers should lose no opportunity of giving their scholars an intelligent knowledge of the surroundings of ordinary rural life and of showing them how to observe the processes of nature for themselves. One of the main objects of the teacher should be to develop in every boy and girl that habit of inquiry and research so natural to children; they should be encouraged to ask their own questions about the simple phenomena of nature which they see around them, and themselves to search for flowers, plants, insects, and other objects to illustrate the lessons which they have learnt with their teacher.

The Board consider it, moreover, highly desirable that the natural activities of children should be turned to useful account—that their eyes, for example should be trained to recognise plants and insects that are useful or injurious (as the case may be) to the agriculturist, that their hands should be trained to some of the practical dexterities of rural life, and not merely to the use of pen and pencil, and that they should be taught, when circumstances permit, how to handle the simpler tools that are used in the garden or on the farm, before their school life is over.

The Board are of opinion that one valuable means of evoking interest in country life is to select for the object lessons of the lower standards subjects that have a connection with the daily surroundings of the children, and that these lessons should lay the foundation of a somewhat more comprehensive teaching of a similar kind in the upper standards. But these object-lessons must not be, as is too often the case, mere repetitions of descriptions from text-books, nor a mechanical interchange of set questions and answers between teacher and class. To be of any real use in stimulating the intelligence, the object lessons should be the practising ground for observation and inference, and they should be constantly illustrated by simple experiments and practical work in which the children can take part, and which they can repeat for themselves at home with their own hands. Specimens of such courses can be obtained on application to the Board of Educa-

tion. These may be varied indefinitely to suit the needs of particular districts. They are meant to be typical and suggestive, and teachers, it is hoped, will frame others at their discretion. Further these lessons are enhanced in value if they are connected with other subjects of study. The object-lesson, for example, and the drawing lesson may often be associated together, and the children should be taught to draw actual objects of graduated difficulty, and not merely to work from copies. In this way, they will gain a much more real knowledge of common implements, fruits, leaves, and insects than if these had been merely described by the teacher or read about in a lesson-book. Composition exercises may also be given—after the practical experiments and observations have been made—for the purpose of training the children to express in words both what they have seen and the inferences which they draw from what they have seen; and the children should be frequently required and helped to describe in their exercise books sights of familiar occurrence in the woods and in the fields. Problems in arithmetic connected with rural life may also be frequently set with advantage.

The Board of Education also attach considerable importance to the work being done by the elder scholars outside the school walls, whether such work takes the form of elementary mensuration, of making sketch plans of the playground and the district surrounding the school, of drawing common objects, ponds, farms, and other suitable places under the guidance of the teacher, or of the cultivation of a school garden.

The teacher should as occasion offers take the children out of doors for school walks at the various seasons of the year, and give simple lessons on the spot about animals in the fields and farmyards, about ploughing and sowing, about fruit trees and forest trees, about birds, insects and flowers, and other objects of interest. The lessons thus learnt out of doors can be afterwards carried forward in the schoolroom by reading, composition, pictures, and drawing.

In this way, and in various other ways that teachers will discover for themselves, children who are brought up in village schools will learn to understand what they see about them, and to take an intelligent interest in the various processes of nature. This sort of teaching will, it is hoped, directly tend to foster in the children a genuine love for the country and for country pursuits.

It is confidently expected that the child's intelligence will be so quickened by the kind of training that is here suggested that he will be able to master, with far greater ease than before, the ordinary subjects of the school curriculum.

REGULATIONS FOR CASTLETON AND HILL GARDENS.

Castleton Gardens.

1. All games, such as running, jumping, or flying kites, are prohibited.

2. Any employe selling flowers, plants, &c, without at the same time giving a receipted bill for the money, will be instantly dismissed. Visitors are requested to insist on having receipts.

3. On Sundays no orders can be received, and no flowers, plants, &c., will be sold.

4. Employes giving away flowers, leaves, &c., or allowing any visitor to take them, are liable to instant dismissal.

5. Visitors shall not climb any tree, nor walk on any bed or border.

6. Visitors shall not touch, cut, or pick any flower, leaf or twig, nor in any way to injure any plant

7. Visitors shall observe strictly any notices that may be exhibited for their guidance.

8. Any person who conducts himself in a disorderly manner, or who is not decently clothed, or who contravenes any of the Regulations may be removed from the Garden.

9. Any person who does any act in contravention of any of these Regulations, will be prosecuted under Section 5 of Law 4 of 1899, whereby he is liable to a penalty not exceeding £5, and in default of payment, to be imprisoned for a term not exceeding one month with or without hard labour.

10. The whole or part of the Garden may be closed at any time for any period, by order of the Governor, on notice being given in the Gazette, and at the gates of the Garden, at least seven days beforehand.

11. The Garden shall be open every day from 6.30 a.m, and shall be closed at the following hours in the evening:—

During October, November, December and January at 5.30.

During February, March, April and September, at 6.0.

During May, June, July and August, 6.30.

12. A bell shall be rung a quarter of an hour before closing time, as a notice to visitors.

HILL GARDENS.

1. Any employe selling flowers, plants, etc, without at the same time giving a receipted bill for the money, will be instantly dismissed. Visitors are requested to insist on having receipts.

2. On Sundays no orders can be received, and no flowers, plants, etc., will be sold.

3. Employes giving away flowers, leaves, etc, or allowing any Visitor to take them, are liable to instant dismissal.

4. Visitors shall not touch, cut or pick any flower, leaf or twig, nor in any way to injure any plant.

5. Visitors shall not climb any tree, nor walk on any bed or border.

6. Anyone found trespassing in the Plantations, or cutting or gathering wood, posts, grass, or anything of value, the property of the Public Gardens and Plantations, or being in possession of such and unable to give a satisfactory explanation, will be prosecuted.

7. Anyone found maliciously damaging, or known to have maliciously damaged, or caused to have damaged, any stock, fence or portion thereof, gate, building, tank, tree, plant, or anything of value, the property of the Public Gardens and Plantations, will be prosecuted.

8. Visitors shall observe strictly any notices that may be exhibited for their guidance.

9. Any person who conducts himself in a disorderly manner, or who is not decently clothed, or who contravenes any of the Regulations may be removed from the Garden.

10. Any person who shall do any act in contravention of any of these Regulations will be prosecuted under Sec. 5 of Law 4 of 1899, whereby he is liable to a penalty not exceeding £5, and in default of payment, to be imprisoned for a term not exceeding one month with or without hard labour.

11. The whole or part of the Gardens may be closed at any time for any period, by order of the Governor, on notice being given in the Gazette, and at the gates of the Gardens, at least 7 days before hand.

12. The Gardens shall be opened every day from 7 a m. to 4 p.m.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

Library.

Europe.

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Annals of Botany, June. [Purchased.]
Botanical Magazine, June. [Purchased.]
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Garden, June 16, 23. [Purchased.]
Gardener's Chronicle, June 16, 23. [Purchased.]
Nature, June, 14, 21. [Purchased.]
Pharmaceutical Journal, June 16, 23. [Editor.]
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Cape of Good Hope, Agri. Journal, May 10. [Dept. of Agri.]
Central African Times, May 5, 12. [Editor.]
Agri. Journ. and Mining Record of Natal, May 25.

West Imdies.

Jamaica.

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Ottawa.

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19 (Stigmonose: A disease of Carnations and other Pinks)

Experimental Station.

Alabama, Auburn

108 (Tomatoes)

California, Berkeley

129 (Report on the condition of Olive Culture in California)

Michigan, Agricultural College

179 (Sugar Beet Investigations)

180 (Some Insects of the year 1899.)

Vermont, Burlington

78 (Analyses of Commercial Feeding Stuffs)

79 (Analyses of Commercial Fertilizers)

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101 (Orchard Technique. Apple production in Virginia)

102 (The Crop Pest Law)

American Journal of Pharmacy, July. [Editor.]

Torrey Club Bulletin, June. [Editor.]

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Planter's Monthly, Hawaii, June. [Editor.]

SEEDS.

From Rev. H. H. Scotland, Vale Royal.

Erythroxylon areolatum.

Brunfelsia sp.

White lignum vitæ

From R. K. Tomlinson, Esq., Lacovia.

Lagetta lintearia

Nelumbium luteum.

From Govt. Botanic Gardens, Saharanpur.

Amoora Rohituka

Calotropis gigantea

Cedrela Toona.

Dendrocalamus Strictus.

Diospyros Embryopteris.

Erythrina vespertilis.

Eugenia latifolia.

Garcinia Livingstonei.

Milletia glaucescens.

Pongamia glabra.

Sterculia fulgens.

From Botanic Gardens, British Guiana.

Victoria Regia.

PLANTS.

From R. K. Tomlinson, Esq., Lacovia.

Mammea americana.

HERBARIUM.

From Dr. Grabham, Kingston.

Clusia sp.

Canella alba.

From Rev. H. H. Scotland, Vale Royal.

Erythroxylon areolatum.

[Issued 4th August, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] SEPTEMBER, 1900. Vol. VII. Part IX.

ORANGE CULTURE AND DISEASES.*

The orange tree of which we are about to trace the history, belongs to the order Rutaceæ and to the tribe Aurantiaceæ of which it forms the type, and is among the most beautiful gems of the vegetable kingdom. A tree which is so agreable in every way, must have attracted the attention of man from the earliest dawn of civilization.

It was supposed by the older botanists that the orange tree was a native of Mauritania and that the golden apples which Hercules carried away from the gardens of the Hesperides must have been oranges. Cœlius declares that the orange tree was introduced from Mauritania into Media, (Northern Persia) and thence into Greece and Italy. But though the orange tree is naturalized in several places of Algeria and Morocco, it is never met with in a really wild state. Several authors affirm that the orange tree was known to the Romans who called it Citrus, but there are data to prove that the Romans applied this name not to the orange but to the lime or citron, which towards the end of the 2nd century they had introduced from Media and Palestine into Italy.

According to several Arab writers the orange tree was brought by the Arabs from the countries beyond the Ganges, and that after the 300th year of the Hegira, about the 10th century of the Christian Era, they spread it into Asia Minor, Palestine, and Egypt, and became very common in the gardens of Tharsus, whence it was distributed to all the countries bordering on the Mediterranean, where they had established their empire. In fact modern travellers attest that the wild orange and lemon trees are very abundant in the forests on the southern slope of the Himalaya beyond the Ganges.

The sweet orange grows wild in the Southern Provinces of China, in Northern India, Amboyna, the Banda Islands, and in several islands of the Pacific. Several writers, among whom is the celebrated Loureiro, affirm that the sweet orange tree was imported into Europe by the Portuguese, about the 14th century. From Portugal the orange tree seems to have passed to the countries bordering on the Mediterranean sea. But there are reasons to believe that at least in Asia Minor and Palestine, and also in several islands of the Mediterranean, among which is Malta, the sweet orange, usually called the ordinary

* A lecture on 'Orange Culture and Diseases' delivered by Dr. J. Borg, M.A., M.D., at the Malta Archeological and Scientific Society.

or flat orange, was received direct through the Persian Gulf, although its variety, the oval orange, must have been really a Portuguese introduction.

It is with the greatest difficulty, that we can trace the numerous varieties of the orange tree to their respective species. Thus it is now universally admitted that the bitter or Seville orange, which is still by many authors considered as a distinct species (Citrus Bigaradia), assumed its rough peel and bitter taste after its introduction into Europe. Also, the sweet orange has been made to assume numberless forms in the European gardens, although the principal varieties of this delicious fruit have been produced by special conditions of soil and climate of their new home, and not by the ingenious contrivances of cultivators. The curious form of the orange tree known as Bizarre, is remarkable for producing on the same branch and often in the same bunch perfect lemons and perfect Seville oranges, the pips of the fruit similar to the Seville orange will germinate and produce Seville orange trees, and the pips of the fruit similar to the lemon will produce lemon trees. Therefore, unless we are ready to admit that two distinct species may originate from the same tree, we must agree that the orange and the lemon tree are, in fact, varieties of the same species. It is the general opinion of botanists that the lemon, the citron, the lime, the bitter and the sweet orange, the mandarine orange and others, are merely several distinct forms of the same species of the wild lime which grows in the forests of Northern India and Southern China.

The orange tree flourishes in a great diversity of climates, but too much heat and too much cold are alike contrary to it. The orange tree is a large-leaved evergreen; moreover its buds are not covered with the scales and cottony substance which cover the buds of deciduous trees, that is, it has no provision to resist the severe cold of northern latitudes. Although we cannot agree with the old writers, who stated that the orange tree cannot grow beyond 50 miles from the sea-shore, yet in the regions situated near the sea, the temperature is more uniform, and there the orange tree, which is peculiarly sensible to variations of temperature, flourishes better than in inland countries. The direct heat of a tropical sun is unfavourable to the development of the orange tree, and there it requires the shade of large forest trees, to bring its fruit to maturity.

A locality exposed to the northern winds is not suited for an orange grove. We find that the forests where the orange tree grows wild are situated on the southern slope of the Himalayan and Quen-lun Mountains. A northern situation retards the blooming season and exposes the trees to the immediate action of cold winds, which strip them of their leaves and dry up the new twigs, so that in a severe winter the tree ceases to be an evergreen.

Too sandy and too compact soils are alike unsuitable for the regular growth of the orange tree. This tree, when planted in a sandy soil, is very liable to suffer from dry weather. A sandy soil is, generally speaking, a poor soil, because the nutritive compounds on which the tree subsists are very readily carried away by rain water, beyond the reach of the roots of the orange tree, which, it must be remembered is essentially a surface feeder. A too compact soil keeps the water stagnant and is one of the chief of causes chlorosis. Moreover the roots are

compelled to remain very near the surface and therefore must be exposed to great heat in summer and to great cold in winter. Also, in a compact clayish soil the root system is particularly subject to dry rot. With regard to the chemical composition of the soil, we may say that the orange tree requires a soil containing a high percentage of carbonate of lime and oxide of iron, and only a moderate quantity of clay (alumina). When the percentage of clay is very high, or when the orange tree is situated on a subsoil of clay, it produces fruit having a very thin rind, and a very luscious flavous, but unfortunately easily subject to rot and cannot be much depended upon for exportation. This is the case of some orange groves at the Boschetto. When the subsoil consists of soft porous rock, the fruit is large, has a thick rind, the oil glands and the aromatic properties are well developed. This may be observed in the orange groves of Casal Lia, Casal Balzan and Casal Attard. If the subsoil is very hard and compact and therefore very dry, as the subsoil of the orange groves at Musta, the fruit is small sized, the rind is thin, but the pulp is very juicy and delicious. Fruit grown on such a subsoil ripens early and is in every way suitable for exportation. Whatever the quality of the soil may be, still we may grow the orange tree to advantage, provided that the soil is so regulated that there will be a perfect drainage. A layer about two feet in thickness, and consisting of rubble and stones, and covered by two or three inches of thin rubbish will constitute by itself a perfect system of drainage to favour the flow of superfluous water in winter. The layer of earth which covers that of rubble should be two feet in depth and never less than 1 foot and a half. As the rootlets will hardly ever penetrate beyond the layer of rubbish, and as drought prevents the formation of roots within six inches from the surface, we may say that the soil in which the orange tree thrives is from twelve to eighteen inches in thickness.

The orange tree does not exhaust the soil very rapidly. The produce of the orange tree are the fruit and the pruned branches so that, strictly speaking, the soil is depauperated of its nutritive substances for the same amount which these substances enter into the composition of the fruit and the pruned branches. If the nutritive elements of the pruned branches are again returned to the soil in the form of wood ashes, we will find that, even after the lapse of several years, the orange grove can hardly be said to be impoverished at all. In the raising of crops of cereals and other annual vegetables we meet with the reverse. In these crops we carry off both the fruit and the plant which produced it, or in other words the earth loses for ever all the nutritive substances absorved by the action of the roots. Now, the vast percentage of the weight of an orange, consists of water and hydrocarbons, and of a few nitrogen compounds which the tree receives directly or indirectly from the air. The small amount of phosphates and potash necessary for the formation of the fruit and the perfection of the orange pips is compensated by the stable manure which is supplied to the orange grove at regular intervals of six or eight years. The effect of a too liberal supply of stable manure on the orange grove is the production of exuberant foliage and large fruit with a thick peel. The fruit loses much of its aroma and become fibrous. On the contrary a soil very poor in nitrogen compounds produces tiny orange delicious in flavour but unfit for commerce. The chemical manures which pre-

ferably should be supplied to the orange grove are the assimilable salts of phosphorus and potash. Already we see that the more experienced foreign cultivators are abandoning the use of nitrate of soda and have taken to use the superphosphates and chloride of potassium in moderate quantities. To this chemical manure I prefer bone-dust and wood ashes, which are cheaper, less active, and have, a more durable influence on the soil Stable manure, particularly cow-manure, is an excellent compost for the orange grove, provided it is sufficiently rotten to prevent any undue fermentation when supplied to the soil. But as it contains a high percentage of nitrogen compounds, a liberal supply should be avoided to prevent the deterioration of the fruit.

The orange tree can be multiplied by seed, by cuttings or by layers; but the practice of propagating the orange tree by layers and cuttings has been long ago abandoned in this Island, and even on the northern shores of the Mediterranean where it was, until lately, the preferred method; it is getting superseded by the propagation by seeds It was, anciently, the practice in these Islands, to raise all the varities of the orange tree directly from seed. Experience teaches us that sweet orange trees thus obtained are very liable to suffer from gummosis; the great bane of the orange grove. Of all trees of the orange tribe, the Bitter or Seville Orange is the least subject to infection by gummosis, and if infected, it is the best constituted to bear it for a long time and often to overcome it. In fact in favourable years such as this year, the diseased bark soon gets covered by a new layer of healthy bark which definitely prevents the extension of the disease. For this reason it is now the common practice to sow the pips of the Seville Orange and when the young seedlings have acquired a sufficient size, they are removed from their beds to a proper place in a nursery, planting them about two feet apart When the trunk is about ¼ of an inch thick it may be grafted with those varieties of the orange tree which we desire to propagate. When the grafted trees have grown enough, they are transplanted in summer with a good ball of earth to their definite place in the orange grove, setting them at a distance of 15 feet apart.

I must pass over, as useless or impracticable, all the various forms of grafts which have been recommended for the orange tree. Some of those grafts, such as the graft Houard, the whip grafting, the saddle graft and others, are used only by amateurs to procure young productive trees of much interest from a horticultural point of view. But the trees thus obtained are very short lived, and the graft itself is a precarious operation, which requires much skill and patience on the part of the gardener. The same may be said of the graft by inarching, which was much recommended by some Maltese orange growers. But although it produces trees of a sufficiently long life, it is not suited for an extensive nursery where the orange grower has to raise hundreds of grafted trees every year. Shield budding is the only kind of graft which I can recommend for the orange tree and of the various methods of shield budding, I prefer the upright T method. "In order to effect this, a longitudinal incision is made through the bark of the stock down to the wood, and is then crossed at the upper end by a similar cut, so that the whole wound resembles the letter T. Then from the scion is pared off a bud with a portion of the bark, having the form of

an inverted cone, and the latter is pushed below the bark of the stock until the bud is actually upon the naked wood of the stock; the upper lips of the wound in the stock and that of the bud are made to coincide, and the whole fastened down together by a ligature." Experience shows that the best time for carrying on this operation is from March to September, on a fine cloudless morning, when the sap is circulating freely under the bark. After two or three weeks, when the graft has succeeded we may loosen the ligature and the young shoot which springs from the bud tied to the upper end of the stock.

The orange tree continues to grow long after the blooming season is over, and throws out new shoots, and sometimes fresh blossoms throughout the summer, being checked only by the approach of winter. It is therefore a tree which requires a large amount of humidity, without which, it not only ceases to grow, but cannot ripen the fruit or even keep it hanging on the branches. It is a surface feeder requiring a large allowance of air for its roots, but at the same time cannot tolerate protracted dry weather, and the necessity of well regulated irrigation is a prominent feature in our orange groves. It is usual to begin watering the trees about the middle of June. But when we have a sandy soil or a very open subsoil, or when we have a rainless and windy spring we cannot stick to this date, without risking the crop, nay the life of the trees. In a deep soil it is enough to water the trees once every three weeks, but in a shallow and particularly in a sandy soil the intervals between one irrigation and another should not be longer than fifteen days, and the water should be distributed over a larger area. It was said that slightly brackish water is not suited for the orange tree. Certainly, pure, well ærated fresh water is much better, but it has been proved that brackish water is not dangerous, and that it does in no way interfere, with the quantity or quality of the crop.

The orange tree should be tilled at least twice a year. The first tillage should be performed some time after the first rains, to remove the weeds and open the earth to enable it to receive better the succeeding showers. The second tillage should take place in April or early in May to remove the lingering weeds and to loosen the surface of the soil so as to prevent a too rapid escape of the moisture. But when the weeds are very abundant, the grove should be tilled a third time early in March to prevent the weeds from running to seed.

In well regulated orange groves, pruning is attended to at least once every three years. In this important gardening operation we must take care not to be too free with the pruning knife so as to make the tree a cripple. All branches situated within the tree are fruitless and should be removed. The small dry twigs although troublesome to deal with, should not be suffered to remain. Besides being unsightly they are the source of much mischief to the young fruit and twigs. Diseased branches having the symptoms of gummosis should be removed in order to save the tree. Too many wounds on the same branch should be avoided. But a large wound is worse than several small ones, because it cannot close and usually forms the starting point of canker which ultimately kills the tree. When the wound is of some size it should be covered by some impermeable mixture which keeps off rain water and at the same time keeps the wound

cool and thus helps it to remarginate. A well kept orange tree should be treated in pruning so as to assume a low hemisphærical form, which renders it more productive, more easy of access, and less liable to be damaged by bad weather.

DISEASES.

The diseases to which the orange tree is subject may be divided into three large groups (a) Diseases of animal origin which are caused by animal parasites (b) Diseases of vegetable origin, caused by fungus parasites, and (c) Intrinsic diseases which are crused by errors of assimilation or by unsuitable surroundings.

The diseases of animal origin are, by far the most important as they have a direct bearing on the crop. The number of insects with which we have to deal in the orange is legion, and they are continually increasing. Their havoc may be shown by stating that an orange grove infested with the fruit fly has about 1/3 of its crop ruined by these insects; and this year I have known several orange merchants refusing to buy the crop of the orange groves of Casal Lia, Balzan and Attard because the fruit was hideously disfigured by the new scale insect Parlatoria Lucasi. Some years ago many orange groves were so badly infected with the Mytilaspis that many branches withered up and in some cases the trees had to be removed. On the other hand there are many insects whose beneficial influence is much felt in the orange grove and which are the truest friends of the orange grower. We shall give a brief description of the most important of both.

Among the Coleoptera, the Cockroach order, there are some insects which gnaw into the trunk of the orange tree. Although these insects are common in America and in several European countries, I have never noted any borer of the living wood of the orange tree in these Islands. But there is a Coleopterous insect of great beauty which feeds on the leaves and blossoms of the orange tree. This insect Cetonia Aurata is an inch in length, has its wing-cases (elitræ) of a bright green colour. Its head and the upper surface of the Thorax are of the same colour. Its abdomen is bright purple. It is by no means a very common insect and the damage caused by it is hardly noticeable The Lencocælis funesta and the Epicometis squalida are two Colepterous insects which sometimes may be met with on the orange blossoms, although they never gave any real cause of complaint to the orange grower.

The Coccinellidæ, a family of the Coleoptera are represented in our Island by some very useful friends of the orange groves. Thus Chilochorus bipustulatus, Exhocomus quadripunctatus, Coccinella septempunctata, Coccinella undecimnotata, Adalia bipunctata, Halizia decempunctata and one or two species of Scymnus, are particularly the first two in the list, common denizens of the orange groves. The larva of the Chilochorus bipustulatus lives by eating the young larvæ of many parasites of the orange tree, particularly the larvæ of the Scale insects. In its adult state it is of ths size and form of a grain of wheat, covered all over with black hairs, and having a transverse white stripe in the middle of its back. Arrived to maturity it fixes itself on the under surface of a branch or leaf and becomes a chrysalis. There it undergoes the usual metamorphosis and in a few days sallies-forth a perfect

insect a beautiful small beatle eager, as when it was a larvæ, to continue a relentless war upon the Scale insects.

Among the Hymenoptera we count only true friends of the orange groves. Such are several species of ants, particularly the red headed ant "Formica rufa," which I have seen carrying off in its jaws the larvæ of the Scale insects. But they may also cause some damage when they attempt to form a nest in the cankered trunk, as they exhale a certain quantity of formic acid which induces the wood to rot more rapidly. They may also gnaw asunder the young shoots for the sake of the juice which contains a certan dose of sugar. Bees are other hymenopterous insects which are among the most beneficial visitors of the orange grove. In their busy rambles among the orange trees, they carry the pollen, the fertilizing agent of the flowers, from one blossom to another. This inter hybridization of the flowers, is known to give new energy to the ovary, fertilization is more perfectly conducted, the seed is strong enough to arrive to maturity, and the crop is thereby rendered more abundant. It is a notorious fact that in this Island, since the honey bees are no longer seen in swarms hovering over the orange groves these are not producing so large crops as they formerly used to do. Early in summer, on the first hot southern winds we see the young fruit, assuming a yellowish, colour, and dropping by thousands, not being strong enough to draw from the tree the nourishment required to grow, and to bear the heat of the sun.

If we examine attentively the larger kinds of Scale insects we find that many of them have a small puncture on the surface; and if we crush one of these scales with the finger, we find that it is quite dry and empty. The puncture was made by a small winged insect, Aphelinus fuscipennis, whose larva had nourished itself at the expense of the body of the Scale insect. The proportion of Lecanium Oleæ (one of the Scale insects) destroyed by the Aphelinus varies from 25 to 75 per cent

Among the Neuroptera we find two species of Chrysopa, the Lace fly, viz: Chrysopa Citri and Chrysopa perla which wage a steady war against the Aphideæ These two insects having the appearance of mosquitoes are very similar to each other. The Chrysopa Citri is a four winged insect about half an inch in length of a bright green colour. Its wings are all of the same size and transparent. This insect both when it is a larva and when it is an imago, is a deadly enemy of the Aphis, a single individual destroying hundreds of Aphis in 24 hours. When it appears in great numbers, its eggs may be seen at the extremity of small filaments attached to the margin of the leaves in trees infected with the Aphis.

Among the Lepidoptera there are some species of butterflies, whose grubs destroy the orange-blossoms in the groves of Sicily and Italy. Fortunately they have not made yet their appearance in this Island, but we may expect to see their cocoons imported along with Sicilian oranges. We have a small moth Dacruma coccidivora, which is a true friend of the orange grove. It is a small white moth, measuring about half an inch between the tips of its wings. Upon its forewings there is a black mark like the letter S. The grub feeds upon the the scale insects and spins for itself a cocoon upon which it fixes the scales of the insects it has eaten. I found this moth for the first time

in Musta, but afterwards I met with it in Casal* Balzan, Lia and Attard.

We find two species of flies (Diptera) which are the worst foes of the orange groves and of orchards in general. One of these fruit-flies, Halterophora capitata is more common than the other. It came from India through Suez Canal, Egypt, Greece and Sicily, whence it probably came to Malta along with Sicilian oranges. It is about 1-6 part of an inch in length, a little smaller than the common house-fly with a white head, having a yellow line across its forehead. Its antennæ are yellow covered with white hairs; Its thorax is black with four white lines. Its abdomen striped with yellow add white lines alternately. Its legs are yellow; its wings, which are always kept outspread, have yellow lines and small black dots towards the tip. It likes to bask in the sun, squatted upon the fruit and leaves. The other fruit-fly, Halterophora hispanica, was known long ago in the Azores, Portugal and Spain, whence it passed into Morocco, Algeria. Tunis and Tripoli, and finally made its way to Malta, but it is not so commonly met with as the other. Its general colour, viewed from a distance, is greyish green. Its wings, except when flying are always kept folded up, and are perfectly transparent. This fly shuns the sun, and is generally found upon the shaded trunk and branches, and goes on the fruit only to lay its eggs. When the fruit-fly is about to lay its eggs in October, it seeks the fruit which is most exposed to the sun, as it has a thinner peel. With its ovipositor it makes a small puncture in the peel. and at the same time drops from four to fifteen tiny white eggs. If the weather is hot the eggs are hatched in about six days, and the small grubs pierce through the fruit, destroying the pulp. In about five days the grubs will grow to the adult stage and the fruit dropping down, the grubs quit it and hide themselves in the earth, boring down to about an inch from the surface. There they assume the chrysalis state, in which they resemble a grain of wheat, though somewhat smaller. If warm weather continues, in five days more, the perfect insect (the fruit-fly) issues forth from its low abode to renew the havoc If cold weather sets in, the chrysalis enters into a lethargic state for the rest of winter, and only awakens to winged life towards the end of April. Among the numerons methods proposed to rid the orange groves of this pest we will mention only two. The perfect insect can be caught by means of small boards besmeared with honey and turpentine. The greedy insect goes to sip the honey and is taken hold of by the turpentine. Three boards thus besmeared, upon each tree, are quite enough. The second method consists in kidnapping the grubs while they are busily destroying the precious crop. All dropped, half rotten fruit should be gathered every morning and disposed of as quickly and effectually as possible. Some cultivators sprinkle it with petroleum and burn it. Others bury it deep underground. It is usual, in following this last practice to dig a long ditch, and to spread a layer of quicklime at the bottom; upon this is thrown a layer of the infected fruit, and then another layer of quicklime, and so on, till the ditch is filled to half a foot from the surface, the whole mass is then covered with earth, and well pressed down, and on

no account should the ditch be opened before the lapse of six months, when the insects and cocoons will be dead, and the rotten fruit will be found to afford a good compost for the orange groves.

The Toxoptera Aurantii or Aphis Aurantii is particularly harrassing to the new shoots of young orange trees, although it is common to see it on large fruit bearing trees. The young leaves infected with this insect develop themselves irregularly, become wrinkled and curled. The flowers drop without blooming or soon after blooming and the tree is greatly exhausted. This Aphis has many enemies among which are the lady-birds and the laceflies already noted,—and were it not for this, its prodigious power of increase would soon make orange culture an impossibility Tobacco decoction, tobacco fumigation, soot, spraying with cupric solution, with petroleum emulsion, &c., are equally efficient methods of getting rid of this insect.

The Scale insects are the most familiar of all pests of the orange grove. They are generally of a small size, but their vast numbers make them conspicuous even at a distance They increase with such marvellous rapidity, as to cover whole orange groves in a few days; so that even when the trees appear almost clear of scale insects, with favourable weather a new outbreak of the disease may be expected.

The White Scale insect Aspidiotus Limoni is rarely seen on the orange tree It is as small as a pin's head; of a flattened conical shape, and perfectly round. The scale itself is transparent, the body of the insect appearing as a yellow dot in the middle of the scale. When this insect is very numerous, the scales can be obtained in large flakes sticking together. Another form of Aspidiotus is the A. Nerii which is found more often on the Oleander. The male insect is smaller than the female, and a portion of its life is passed as a scale insect but having undergone the third month, it issues forth a small gnat-like insect, multitudes of which are constantly hovering in swarms among the orange trees.

The large black Scale insect, Lecanium Oleæ is an old foe of our orange groves. For its permanent abode it select the green twigs, and is seen but seldom upon the leaves. It is a black, wrinkled scale of the size of a small pea, nearly hemisphærical in shape. When young, the almost invisible larva wanders upon the foliage and twigs of the orange tree. After a few hours of this wandering life, it seeks, for itself a suitable place where it fixes itself, loses its legs, and secretes a small waxy scale which covers its whole body, and which increases in size with each moult.

The Mytilaspis citricola is another scale insect having the form of a grain of sesame or of a comma. It is deep brown; its variety Mytilaspis flavescens being light brown. At the pointed extremity of the scale is found the head of the insect, whose mouth consisting of two mandibles and four bristles, is immersed in the substance of the leaf eagerly absorbing the sap. This scale insect is more commonly seen on the green parts of the tree, sheltered from the direct rays of the sun.

The small black scale insect, known as Parlatoria Lucasi, is a flat, black scale of an elliptical shape, surrounded by a white waxy margin, and having at one extremity, where the head is found, a black dot-like small scale which is the first tunic secreted by the insect, soon after it

had ceased to be a larva. The male insect is much smaller, and is represented in the early stage, before it awakens to winged life, by a white scale, having a black dot at one extremity. Parlatoria Pergandi is a new scale-insect recently imported from Italy. Presently, it is limited to some orange groves at Casal Lia.

The Ceroplastes Rusci is a scale insect which is commonly met with on the Fig-tree, and is rarely seen on the orange-tree in this island, although in foreign countries it is a notorious offender.

The Lecanium hesperidum is a grey coloured scale insect, about the size and colour of a hemp-seed. It has a soft scale which renders it an easy prey to its enemies. The same thing may be said of the Lecanium hemisphæricum, a round shaped insect of a rusty colour, having a soft covering like the preceding.

The Dactylopius destructor, usually known as mealy-bug, is very well described by this name and is a great foe of the orange tree in Northern latitudes.

The scale insects may be cleared off the orange grove, by sprinkling the trees with petroleum emulsion, or by fumigating the tree with hydrocyanic acid. But this treatment should be carried out when the larvæ are quitting their mother scale, and unless all orange groves of the same neighbourhood are similarly treated, we shall have a new outbreak in a few months.

The diseases of the orange tree which recognize as their cause the presence of fungus parasites are so numerous, that a descripiion of them would afford matter enough for a large volume. I can only give a brief sketch of three of them.

Thus the Meliola Penzigi, the black blight of the orange tree, also called Fumago or Capnodium Citri, make its first appearance towards the end of the autumn, as small black dots on the leaves, the twigs and the fruit. These black dots gradually enlarge, and join together, covering the whole surface with a black soot-like substance. Soon after the fungus dies, and in dry weather, separates from the green epidermis, in large crusts. Besides rendering the tree and the fruit uusightly, this fungus really damages the tree, because it closes up the pores of the leaf and deprives it of the full benefit of sunshine.

Gumming is an infective disease of the orange tree, due to two and probably to more species of fungus (the Fusarium, Fusisporium, Cladosporium and others.) It is characterized by a gummy exudation from the bark, accompanied by the death of the bark and the wood underneath it. Gumming or gummosis is a deadly disease which works great havoc in the orange grove particularly in years of drought. It travels up and down the trunk, disfiguring the tree and finally killing it, although in large trees the ultimate fate may be delayed for 5 or 6 years. The Seville orange resists this disease better than other kinds of orange trees, as I have known Seville orange trees coming over gummosis, and reproducing the bark killed by this disease; and this is one of the many advantages which the Seville orange presents as a grafting stock.

Polyporus obliquus is also a very fatal and by no means a rare disease of the orange tree. It is characterized by the formation of a round or oval shaped woody outgrowth from the trunk and large branches which

it kills. This outgrowth contains the spores of the fungus, and should be destroyed by fire wherever seen.

The diseases of the orange tree arising from errors of assimilation, etc., are Chlorosis, Brontosis, "Die-back," Withers (Maltese Lupa) Antomania, Carpoptosis, Antoptosis, etc. Of these, Chlorosis is a disease common to all vegetables containing chlorophyll, the green colouring matter of plants. Its principal signs are the following; the foliage assumes a yellowish green, then a yellow colour; the tree ceases to grow on the summit, and throws out very feeble, thin yellow twigs from the trunk and larger branches. The flowers drop without blooming; the few flowers which may bloom produce tiny yellowish short lived fruit which never reaches maturity The upper twigs wither and die, and the tree losing its foliage, falls into a state of cachexy from which it cannot recover. In the early stages of this disease, the tree may be successfully treated with ferrous sulphate (green vitriol) or with bone-meal

"Withers" or Lupa is the sudden death of a part or whole of a tree, caused by the sudden supervention of a cool breeze after a protracted sultry calm in the hottest days of summer. It is a purely physical disease, and frequent irrigation is the only remedy which I can suggest. Brontosis, the sudden death of a tree in winter; Anthomania, the production of an extraordinary quantity of flowers; Anthoptosis the fall of the flowers without blooming, and therefore before fertilization can take place; Carpoptosis the fall of the young fruit and other diseases of the same nature are due to a defective nutrition, and are largely influenced by the meteorological conditions of the season in which they oppear.

In the discussion that followed the delivery of the lecture, Dr. Borg, in reply to a question stated that:—

"The blood orange is native variety of the Maltese islands. There were several opinions about the origin of the blood orange. Some said it was produced by a graft of the pomegranate on the orange tree which was quite impossible as those two trees belong to very different orders in the natural system of botany, and they cannot be grafted on each other. Of course this opinion was formed from the colour of the pomegranate which appears in the blood orange. I think it is a native hybrid, and that it was raised from a seedling of the common orange being influenced by a highly oxidized soil, which caused those blood red spots in the pulp. There was formerly another opinion which was that the blood orange of Malta was a hybrid of the ordinary blood red orange (Citrus hierochunticum) but afterwards I found out that this opinion could not be held, as it could not be proved that the C. hierochunticum was ever cultivated in Malta. The oval or long blood orange is a very recent introduction into Malta. It originated about 40 years ago, upon a tree of the oval orange, a branch of which, produced oval blood oranges, a freak of nature which was propagated by budding. In fact we have no oval blood orange trees more than forty years of age. These are only subvarieties of the orange tree, and any difference between them is so slight that a botanist should not and cannot consider them as being different. In fact there is no difference at all, as the blood orange tree may produce common oranges without the blood-spots. The ordinary or flat blood orange of Malta

was known to Europe about 150 years ago, and Risso in his Natural History of the Orange tree, describes and figures the blood orange of Malta, and alludes to be obscurity of its origin, and also to the theory to which I have alluded as to its having originated from a graft between the pomegranate and the common orange, which graft he justly declares to be impossible."

Professor Tagliofarro said :—

In following the long list of the enemies which the orange tree has to contend with, one must feel inclined to entertain rather pessimistic views of the future of the tree, and its culture. I entertained these views some ten years back when the *Coratitis Citreperda* called by Dr. Borg the *Halterophora capitata,* made such tremendous havoc, not only in orange groves, but in most of the stone fruit trees in Malta. I, and others, were so much alarmed, that I forecasted the utter ruin of fruit culture in Malta. Fortunately nothing of the kind happened and I entertain better views now when I come to learn that when a new insect or a new enemy presents itself, although at first it spreads and produces a great deal of harm, after a certain time it meets with so many enemies that if it does not actually disappear, it loses so much of its power of doing harm, that it may be considered as becoming interesting, more to the scientist than to the agriculturist. I gather from Dr. Borg's very interesting lecture that besides the enemies, there are so many friends who are enemies of the enemies of the orange tree, that a sort of equilibrium is established, and that no fears are to be entertained on the future culture of the tree. An exception most certainly is to be made with regard to the *Parlatori Lucasi.* I had the benefit of a practical lesson from Dr. Borg five year ago, when he showed me the Parlatoria Lucasi in the orange groves at Casal Lia. He says that the fruit and the leaves are so disfiguered that exporters do not care to buy the crops of Casal Lia, Casal Balzan, and Attard. I was so much impressed with the miserable state to which it reduced the orange trees, that I have been since then on the look-out at Musta to try and prevent it spreading in that locality, and I was so fortunate as to stamp out that disease. On two occasions in the last three years I was fortunate enough to detect its presence when it had infected but two or three, and by lopping off all the leaves and the twigs which were affected, I succeeded in stamping out the disease, and so far, I have reason to believe, there is no actual danger of its being propagated. The Parlatoria Lucasi is at first sight so similar to the Mytilaspis, which is so well known to growers of oranges in Malta, that it is somewhat difficult for those who have never before seen the Parlatoria to distinguish it from the Mytilaspis; and I think it would be very beneficial to the growers and to the agricultural class in general if some steps were taken to show to the growers, practically tho difference between Parlatoria Lucasi and Mytilaspis. I am sure the thing is practicable and in view of the danger,—the imminent danger—and harm that this insect produces on the orange tree, I am sure they would be on the look-out in those localities which have not been hitherto infected. I am throwing out this suggestion in the hope that it will be favorably entertained by the members of our Society, sure as I am that the views of the founder of this Society will be more fully met if our work is

not not limited to the regions of pure science, but its scope extended to matters of practical utility to our fellow subjects.

Sir G. Strickland said:—The lecturer's object has evidently been gained with regard to the classification of diseases of orange trees, but the practical merit of the lecture, in my humble opinion, lies in the part having a commercial aspect where the lecturer pointed out, that by planting the trees in different soils, and treating the trees in different ways, oranges suited for different markets, or of different form can be obtained. It strikes me, that, the principle of adjusting the supply to meet the demand is the beginning of the revival of the profitable growth of oranges in Malta—that has been opened out by those remarks. The lecturer dwelt on the fact that the orange is a very beautiful tree; and it would appear that most people in Malta have lately been cultivating the orange for ornament as the industry had not of late been yielding interest on the capital. Whether we shall continue to grow those trees for appearance sake is a very practical question for many people.

In past years there was no competition and oranges from Malta obtained a great price in an exclusive trade, because word went all over the world that the Malta orange meant the beautiful blood orange. People bought it, and paid a high price for it. Malta was for a time the only locality where the blood orange flourished but other localities have been made available and large groves have been planted along the shores of the Mediterranean, where oranges of all sorts have been grown and shipped all over the world at prices which make the Malta orange cease to be a commercial commodity. I won't discuss California and Florida because they supply quite another market. As all trade and all commerce involves a study of supply and demand, and Malta can only supply a limited market we must look for a demand which will be remunerative for a supply that can defy competition. It appears that the future of Maltese oranges, and Malta as a fruit growing island must be based on following the example of Jersey and Guernsey in supplying articles of very excellent quality. These Islands had a come down in their agricultural system, but enterprising people met the crisis by producing something in the way of fruit which would command a very high price because it was out of season and it was by a long way the best of its kind. That was achieved in Jersey and Guernsey, because they had the public spirit, or rather the enterprise to lay out acres upon acres of glass houses, where the fruit was reared for early placing on the market; and exactly to suit the climate and the crops they had to raise.

Here in Malta, we have perhaps the counterpart of this accident of geographical position and local opportunity. We have the stone with which to build the high sheltering wall essential to growing the best oranges. The high walls are the counterpart in a sense of the glass houses. But orange growers for commercial purposes should give up the idea that the ordinary orange is a fruit that is worth growing in Malta, we should therefore aim at growing. In the same way that the blood orange appeared in Malta, or that gigantic potatoes, large tomatoes early grapes and other fruit and vegetables, better sorts of oranges than the blood oranges can be artificially developed, and in Malta we should aim at producing an orange that would, from early appearance

in the market or from its being considered suitable for carriage or from its being particulary fine, command the highest price in the London market.

Commerce cannot exist without organization. There must be good packing and good selling agents. It is no use for one exporter to collect several dozen boxes of oranges to sell, for there must be a steady flow to command high prices and a constant market. The buyers require to know where they can get the accustomed article of uniform quality and that want can only be met by good organization on the part of the grower to enable him to please and keep his customers.

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SEEDS.

From Botanical Dept., Trinidad.
Sweet Potatoes, 4 varieties.
Amaranthus sp.
Lucuma n. sp. (Forest Tree).

From Botanic Station, Honduras.
Honduras Mango Seeds.

From Supt. Govt. Hort. Gardens, Nagpur, India.
Hardwickia binata.

From Curator, Botanic Station, St. Vincent.
Java Plum.

From Govt. Botanic Garden, Saharanpur.
Buchanania latifolia.

From Laurence Tate, Esq., Shafston.
Lime.

From Maurice Schleifer, Esq., Guayaquil.
Pods of Cocoa.

From Fickhert-Forst Hnos., Guatemala.
Rubber.

From Messrs. ReasonerBros., Oneex, Florida
Cocos Alphonsii.

PLANTS.

From Messrs. Reasoner Bros., Oneca, Florida
7 Oleanders (nearly all dead)
9 Nymphæas.

[Issued 4th September, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] OCTOBER, 1900. Vol. VII. Part X

MOTH-BORER IN SUGAR CANE.**

By H. Maxwell-Lefroy, B.A.
Entomologist, Imperial Dept. of Agriculture for the West Indies.

Our knowledge of the attacks of insects on sugar cane dates from about the beginning of the 18th century, when Sir Hans Sloane mentioned a "worm eating the sugar canes" in Jamaica. This insect is supposed to have been the same as that studied by the Rev. L. Guilding in St. Vincent in the year 1828, called by him Diatræa sacchari.* Since that time a considerable amount of literature has accumulated with regard to this pest, now known as the moth-borer, *Diatræa* (Chilo) *saccharalis*. The moth-borer of the West Indies is widely distributed in the New World, and extends even to India † Its place in the Old World is taken by other closely allied moth-borers, where ever sugar cane is cultivated. In the "Kew Bulletin"‡ there are many references to this insect and a complete account has been given by Cockerell in the Jamaica Bulletin for April, 1892. In America, Professor J. H. Comstock, the late Professor Riley and Dr. Howard and other writers have described the attacks of moth-borer on Indian Corn. During recent years, a considerable amount of attention has been paid to this pest in the West Indies, but, with the exception of those mentioned already, no complete study of the attack of moth-borer in any West Indian Colony appears to have heen made. Though the eggs have been described, no remedies based on egg collecting can be found in the available literature. The recommendations made by many observers have been based largely on the accounts of this insect's ravages on Indian Corn, or on methods recommended in other localities where the conditions, climatie and otherwise, are not the same as those obtaining in the West Indies.

From the time the young shoots show themselves above the ground, the moth-borer commences its attack, and unless measures are taken to check or entirely destroy this insect, it will continue to grow and multiply at the expense of the sugar which should be obtained when the cane is reaped. If sugar planters wish to get the full amount of sugar

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* "Transactions of the Society of Arts," vol. XLVI, 1828, p. 143.

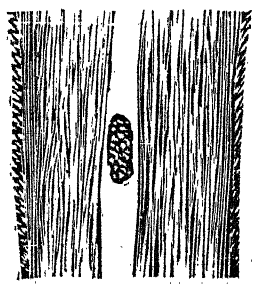
† Cotes, 'Notes on Indian Insect Pests,' "Indian Museum Notes," part III.

‡ "Kew Bulletin," 1892, p. 153, (with plate); 1894, p. 169.

their land will produce, they must adopt remedies to protect their crop from the ravages of pests which want the sugar as much as they do. No measures are likely to be satisfactory which are not specially suited to the habits of the insect; it is necessary to clearly understand how, when and where the cane is attacked, and above all to find out at what time and in what way the pest is most open to attack. If the life history and habits of the moth-borer were fully understood, remedies would suggest themselves and could be intelligently and successfully applied.

LIFE HISTORY OF MOTH-BORER.

The life of the moth-borer falls into four periods; (1) the egg; (2) the caterpillar or "worm"; (3) the chrysalis; (4) the moth. The injury to the sugar cane is done entirely by the caterpillar; the chrysalis is simply the resting stage, while the moths live solely for the purpose of laying eggs.



Part of a leaf of a young cane plant, with a patch of Moth-borer eggs. Natural size.

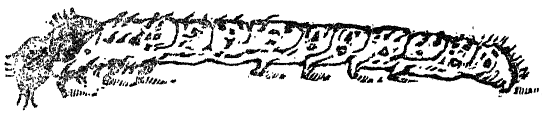
Eggs.—The eggs should be familiar to anyone who sees young canes. They are laid on the leaves, usually on the midrib, and on young plants can be found with great ease. They are flat, oval in outline, laid in patches, one egg partly overlapping another like the tiles of a house. A single egg is $\frac{1}{25}$ in. across, about the size of this letter "o." There may be as many as 57 in one egg-patch or as few as six, but the average number in each of 80 lots counted was found to be about 20. A patch of eggs is readily seen on a leaf owing to its colouring and peculiar form. Both sides of the leaf should be examined and the whole length of the leaf from the tip downwards. The colour of the eggs when freshly laid is a creamy-white, but as time goes on they become orange and when the caterpillar is ready to come out they are orange-brown with a black spot. The caterpillar is hatched in 5 or 6 days and the empty egg cases are white.

Moth borer eggs are attacked by a parasite that does good service by destroying the caterpillar before it can come out of the egg. Eggs containing parasites are black, and are thus distinguished from the ordinary eggs out of which caterpillars come.

If these black eggs are kept, numbers of minute flying insects will emerge. Two kinds of eggs can thus be found on the cane plants: First, the ordinary eggs of the moth borer, which will pass through the changes of colour described above, and from which borer caterpillars come: Second, the eggs of the moth borer that contain parasites, which eat the contents of the eggs, and prevent the formation of a borer caterpillar; the latter are black, and remain so till after the flies have come out. Careful examination of the eggs will show whether they contain caterpillars or parasites, the orange or yellow colour distinguishing those eggs without parasites. It is only when the caterpillar

is ready to come out of the egg that the unattacked borer eggs show a slightly black colour. It should therefore be possible, by looking at a patch of eggs, to say whether the eggs will yield caterpillars or parasites.

CATERPILLARS.—On hatching, the caterpillars (" worms") walk down the leaf and, in young canes, on reaching the base they either bore into the leaf sheath or pass down between the leaf sheaths. For 10 days or more they feed on the outer layers of the stem, and then bore



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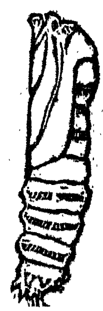
The Moth-borer caterpillar, seen from the side as it appears when taken out of the cane. Twice the natural size of a full grown specimen.

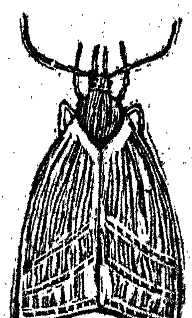
into the centre of the young cane, destroying about three inches of the heart of the cane near the base In old canes, the caterpillars make tunnels in the joints, eating out the solid substance of the cane. After a little over a month (33 to 35 days) when the caterpillars are about 1 inch long, they make a hole to the outside of the cane and then change to the chrysalis.



The Moth-borer Chrysalis seen from the side. Twice the natural size.

CHRYSALIS.—The chrysalis is brown, and is unable to move; it lies in the cane near the hole made by the caterpillar, and is transformed into the moth in five to seven days.

During this time the structure of the caterpillar undergoes changes resulting in the formation of the wings, legs, eyes, and other parts of the moth, besides almost completely new internal organs.



The Moth as it appears when at rest with the wings closed. Twice the natural size.

MOTH.—The moth is greyish in colour and lives two days only. During the day it is inactive, but at night the female flies and lays eggs. One female will lay upwards of 150 eggs, distributed over a number of plants.

The Moth does not appear to be capable of flying far or against the wind: it may be carried for some distance by the wind, but the eggs are laid, in all probability, on plants scattered over a small area, and especially to leeward of the older canes.

The following table shows the length of each stage of the life history and where it is passed:—

STAGE.	DURATION.	WHERE FOUND.
Egg ...	6 days	On the leaf
Caterpillar ...	35 days	In the cane
Chrysalis ...	7 days	In the cane
Moth ...	2 days	Flying about

Hence the maximum length of time required for one generation is 50 days: the whole life from the time of the laying of the eggs to the death of the moth may, however, be only 42 days.

When the life history of this insect is fully understood, it becomes clear that there are two periods of its life when it is easily attacked: (1) the eggs, which are laid openly on the leaves of the cane; and (2) the moths, which fly about. Any attempt to destroy the caterpillar or chrysalis would involve the destruction of the infested cane, which is practicable only in young canes which can be cut out, or very badly diseased old canes which should be removed and burnt.

REMEDIES.

COLLECTING EGGS.—The simplest remedy is to collect the eggs and burn them. The young canes on the whole estate should be examined once a week by boys, who must first of all be taught to recognise the eggs on the young plants. They must clearly understand that the black eggs are not to be touched, but are to be left on the canes. They should go systematically down the rows of canes, carefully inspecting every plant. They must examine both sides of every leaf, and on finding a patch of either cream-coloured, orange, or orange and black eggs the leaf should be cut off below the patch of eggs and put in a bag. Those patches of eggs that are wholly black and have no orange colour must be left on the plant in order that the parasites may escape and destroy more eggs.

The eggs that are cut off, should be brought in and immediately burned.

If it is remembered that there are on the average nearly 20 eggs in a patch, the number of eggs that can thus be easily and cheaply destroyed is seen to be very considerable.

If this remedy were adopted as soon as the young cane commences to show and continued as long as the cane is sufficiently small, there would be no loss from "cut out" canes, and practically all the best shoots would not then have to be destroyed, as at present.

The recommendations recently made contained no reference to the black eggs: it was believed that a certain proportion of the black eggs contained caterpillars and that it would be dangerous to leave these

eggs on the young cane plants More recent investigations have thrown doubt on this and it appears that *the black eggs may be safely left on the young plants.* It would be well therefore to see that the black eggs are left on the leaves and are not taken from the plants when the other eggs are collected It is necessary to encourage the spread of the parasite that will assist in checking the ravages of the moth borer, and this is best done by leaving the black eggs on the cane plants in order that the flies may come out of the eggs and destroy further moth borer eggs. This question will be kept under observation and if it is found that it is dangerous to leave the black eggs on the plants, the Department will advise further in the matter.

The egg is the only stage that is appreciably affected in Barbados by any natural check, and it is reasonable to suppose that, if egg collecting is carried out intelligently and vigorously during the time the cane is growing, the ravages of the moth borer will not only be greatly checked during the later growth of the cane, but in time the numbers of the moth borer will be very greatly diminished.

Destroying the Moths.—A remedy that has been to some extent adopted is that of catching the moths at night by means of lights. If lanterns are hung out in fields of cane, the moths are attracted to the light and can be caught in pans of molasses or kerosene hung underneath. A useful arrangement consists of a wooden tray, 2 feet square 6 inches deep, with a light suspended above it The tray may contain molasses or kerosene or either of these with water. Any arrangement that will keep burning all night and give a good light is all that is needed. A number of these should be placed on the estate near the patches of mature or growing cane, and they require little attention and need cost but little. This remedy is of especial use when the cane has grown too high for the eggs to be collected : but it may at all times be usefully applied to trap the moths that would otherwise lay eggs.

Cutting out affected Canes—Another remedy already generally familiar is that of cutting out "dead-hearts." This term is applied to young shoots bored by Moth-borer and the object of cutting them out is to destroy the caterpillar inside, though this is not so generally known as it should be. It is useless to cut out dead-hearts after the caterpillar has become the moth and flown away. There are three essential points : (1) Begin cutting out dead-hearts early; (2) Continue cutting out regularly; (3) See that they are cut out quite low down, where the shoot comes off from the plant cane. It is evident that six weeks after the moth-borer gets in, it comes out in the form of the moth and lays eggs. It is useless, therefore, to put off cutting out dead-hearts till three months after the canes are up. Also, as the caterpillar is usually to be found quite low down, the dead-heart must be cut low down, or the caterpillar will not be killed.

When dead-hearts are cut out, they should be put in a bag and the caterpillar inside killed without delay. This may be done by feeding the dead-hearts to stock *on the same day that they are cut out.* Dead-hearts should never be left lying about to wither and rot on the land otherwise the caterpillar inside will turn to the moth and escape, or it will walk out and attack the nearest cane plant. If the dead-

hearts are not fed immediately to cattle or destroyed they should be ripped up and the caterpillar inside killed. It is important to remember that the success of this remedy depends entirely on the destruction of the chrysalis or caterpillar inside the "dead-heart."

After describing the methods now recommended for dealing with the moth-borer it may be useful to review former recommendations in the same direction. In Schomburgk's History of Barbados, page 645, there is this statement: "From long continued experience Mr. Guilding discovered that they (the moth-borers) may be almost entirely expelled if the canes are carefully stripped of the dry and useless leaves, under which, as they become loose, the female Borer deposits her eggs." This observation refers to the year 1828, and we must conclude that the moth-borer may possibly during the lapse of years have changed its habits. In old, as in young canes, the eggs are now invariably laid on the green leaves, not under them or in the axils: no cane has been found in Barbados with eggs laid as described above, and the conclusion appears thoroughly established by careful observation in this island that the stripping off of old leaves has no effect whatever on the ravages of the moth-borer. A number of writers since then have devised plans and recommendations for the destruction of this pest. Clearly, any recommendations for the West Indies must be adapted to the local conditions of climate and cultivation: "Countries situated in the Tropics, where there is no winter's rest, require a different treatment from that found suitable in the Southern United States and others, where canes are only growing during about 7 or 8 months of the year."* The recommendations must also be exactly adapted to the habits of the insect under consideration. In reviewing the remedies that are to be found in the available literature only two have been found suitable for adoption in these colonies; these two are catching the moths at lights and cutting out dead-hearts. The first remedy given above (destroying the eggs) is not advocated in any literature available here for reference. It appears to be one that is probably not suited to other localities, or has been overlooked. For the purposes of the West Indian sugar planter, it is likely to give the best results and, combined with others recommended above should be sufficient to completely check the ravages of the pest. It will be useful to notice two cases mentioned in the "Kew Bulletin" (1894, p. 103.) In Queensland, Roth describes how the pest is kept under control, "by sending boys with sharp pocket knives along the rows of cane. The boys detect the dead or dying shoots, and cut them off as close as possible to the parent cutting. They then opened the shoot and destroyed the fat grub." This is an instance where the practice of intelligently cutting out dead-hearts proved successful. The following, recorded by Dr. Morris, shows what has been effected in the Canaries by methods based on a knowledge of the habits of the pest: "In the south-western corner of this island (Teneriffe) a very large sugar estate has been established and is now under the management of Mr. Richard Tonge of the Icod and Dautè Estate Company. On this estate the canes were very severely attacked by moth-borer, which was believed also to attack the maize crops of the island. The injuries to the

* "Kew Bulletin," 1894, p. 174.)

sugar canes were becoming yearly more and more serious. Mr. Tonge was in despair. He carefully studied the habits of the insects and then organised a system of treatment which was steadily pursued for two years. Every person engaged on the estate was taught to recognise at a glance the successive stages of the insect, viz.. the grub, the chrysalis and the mature insect. A small sum was offered for these and payment was made at the close of each day. During one month (February 1893) there were destroyed 46,884 insects in various stages. During the rest of the year the numbers were not so large, but the record kept of them shows that 9,640 grubs were cut out of standing canes, 5,022 were destroyed in the chrysalis stage, and 1,144 moths were caught on the wing. By judicious management and personal influence Mr. Tonge has so thoroughly enlisted the interest of the work people that the moth-borer is becoming less and less plentiful. Its practical extermination on this estate is now only a question of time. The period during which the canes are growing appears to be the most critical time. Women and children are then kept regularly employed in cutting out any canes attacked by the moth-borer, and the grubs are destroyed in their burrows. This is regarded as a most effective plan. It is believed that if this plan alone were regularly pursued in the West Indies for two or three seasons the injuries would be reduced within comparatively small dimensions."*

This plan would no doubt be still more effective if the eggs were collected regularly in addition to the other stages.

In the Report of the Barbados Commission (1894) for destroying the Moth-borer and other pests, the following statement occurs:—"One of the Queensland recommendations is, cut off and burn the first shoots that spring from the planted cane cuttings. These shoots are allowed to grow for about three months, by which time the grubs will have congregated in them. The shoots are then cut close to the ground piled in heaps, and burned. The second crop of shoots soon appears, and the skins of these latter are said to be much tougher and better able to resist the attacks of grubs which may have escaped the burning. The plan is often supplemented by sending in labourers to destroy all the caterpillars they can find in the second growth of canes." This recommendation, if adopted, would certainly affect the ravages of moth-borer only to a very slight extent. It is unsuited to the habits of the borer, and would prove ineffective in the West Indies. As is stated above, it is of little use to cut out young canes three months after they come up. It must be done earlier. The whole period of a moth-borer's life being at the most seven weeks, a number of moths would have escaped from the young canes during a period so long as three months, and the usefulness of the remedy would thereby be greatly impaired. Also, there does not appear to be any cane in Barbados that will resist the caterpillar's attack. Canes of all kinds are attacked, and if caterpillars are shut up in a box with a piece of the hardest White Transparent cane, they will eat their way into the joints in a short time: the ends of the pieces of cane were tied up in cloth to prevent the caterpillars going in at the cut ends

*"Kew Bulletin" 1894, p. 174.

CONCLUSION.—The three remedies given here :—

1. Collecting the eggs.
2. Destroying the moths.
3. Cutting out affected canes

if carried out energetically and intelligently from the first cannot fail to destroy great numbers of moth-borers. Not only will the canes be more vigorous and sugar obtained that is now destroyed by millions of borer caterpillars, but the rind fungus would I think, be greatly diminished. Up to December in each year, rind fungus only gets into such young canes as have been bored by moth-borer.* If it is possible by collecting the eggs, cutting out dead-hearts, and catching the moths at lights, to prevent the caterpillar from boring the canes, rind fungus will no doubt be greatly diminished "Of all insect enemies of the sugar cane the moth-borer is certainly the most serious in Barbados. It attacks all varieties of canes. and hence is not only constantly exposing them to the attack of Fungi or Bacteria, but would in many cases, carry the very spores into its burrows ; besides which, the injury suffered by any cane by the actual attack at least leads to impoverished juice, if not to actual death of the plant. A glance at any of the literature of the cane diseases will convince anyone of the importance which every cane-growing country has attached to checking the spread of the pest."†

The conclusion cannot be avoided that sugar planters can now choose between getting all the sugar their land will yield them, or letting the moth-borer yearly rob them of a large portion of their canes. Every cane that is bored will on being ground yield less sugar than it should and will also give juice containing substances that tend to spoil the cane juice. Good sugar cannot be obtained from canes attacked by moth-borer or rind fungus, as acids and other injurious compounds are formed as the result of the attack. It will well repay everyone interested in sugar planting to see that these remedies are adopted immediately the moth-borer is seen to be at work in the cane fields.

NOTES ON SOME ANDROPOGONS IN JAMAICA.

By WM. HARRIS, F.L.S.

Acting Director of Public Gardens and Plantations.

Andropogon is a genus of grasses of various habit. There are about 200 species, chiefly tropical, and several of these are of economic value. The following are cultivated at the Hope Experiment Station

ANDROPOGON SQUARROSUS, Linn. f. (*A. muricatus*, Retz.) This is the *Khus-khus*, or *Governor Grass*. It is found throughout the Plains and Lower Hills of India, Burma, and Ceylon, and is cultivated in the tropics generally. It grows in large, dense tufts, with stout, spongy aromatic roots which are sparingly branched. The leaves are 1 to 4 feet long, narrow, acute, erect, with scabrid margins. Panicle 6 to 12 inches, conical, erect, borne well above the leaves, purplish in colour.

*Report of the Commission for destroying the Borer and other pests. (Barbados, 1894, p. 3.)

† Report of the Commission for destroying the Borer and other pests). (Barbados, 1894, p. 15.)

This grass is grown to a considerable extent in the hills of Jamaica for the purpose, principally, of binding loose soil and forming embankments on steep hill-sides to prevent wash by heavy rains.

Fibre. In India the roots are used extensively for making aromatic scented mats, called Tatties, which are hung over door-ways and windows and kept wet to cool the atmosphere during the hot season, and they are also in great demand for making fans, ornamental baskets, and other small articles, &c. The grass is suited for the manufacture of paper.

Oil. The roots when distilled with water yield a fragrant oil which is used as a perfume.

Medicine. An infusion of the roots is given as a febrifuge, and a powder in bilious complaints. A paste of the pulverised roots in water is also used as a cooling external application in fevers.

A. SCHŒNANTHUS, Linn. (*A. citratus*, DC.) This is the well-known *Lemon Grass*, or *Fever Grass* of Jamaica. Our grass has never been known to flower, so that some doubt exists as to its identity, although it has hitherto been known here as *Andropogon citratus*, DC. It has been carefully compared with plants of A. Schœnanthus received from Kew, and no difference can be detected. Sir Joseph Hooker, in his Flora of India, does not regard it as a distinct species, and in the Index Kewensis, *A. citratus* is put down as being synonymous with A. Schœnanthus. Like A. squarrosus this species is grown in the hilly districts of Jamaica to bind loose soil along the sides of plantation roads, &c. It is found in the hotter parts of India and Ceylon, wild or cultivated, and it is grown in most tropical countries.

It is a rather coarse grass, forming large tufts, with glaucous, or yellowish-green leaves; and grows to a height of about 3 feet in Jamaica. In India the leaves vary much in length, width, and other respects.

Oil.—Under the name of *A. citratus*, DC., the Dictionary of Economic Products of India, to which I am indebted for much of the information contained in these notes, mentions that this plant yields lemon-grass oil, verbena-oil, or Indian Molissa oil. This oil is chiefly employed in Europe in adulterating true verbena oil. It is largely employed to perfume soaps and greases The annual production of otto of lemon in Ceylon is above 1,500 lbs., valued at 1s. 4d. per oz. There is a large consumption of this otto in the manufacture of Eau de Cologne. This oil is said to be more costly, and less extensively produced than *citronella* ; it is chiefly manufactured in Ceylon and Singapore.

Medicine.—In the Indian Pharmacopœia, this oil is regarded as officinal. When pure it is of a pale sherry colour, transparent, with an extremely pungent taste, and a peculiar fragrant lemon-like odour. The properties attributed to it are, stimulant, carminative, antispasmodic, and diaphoretic; locally applied it is a rubefacient. It is recommended to be administered in flatulent and spasmodic affections of the bowels, and in gastric irritability. In cholera it has been spoken of as a remedy of great value. An infusion of the leaves (tea) is largely used as an agreeable sudorific in mild cases of fever, and as a medicinal vapour bath for the same purpose.

Andropogon Nardus, Linn. *The Citronella.* This grass grows throughout the hotter parts of India, Burma, the Malay Peninsula and Ceylon, wild or cultivated. In its common form it is difficult to distinguish this grass from the narrow-leaved form of A. Schœnanthus. In Jamaica, so far, the two grasses are quite distinct in appearance A. Schœnanthus grows in dense tufts, the leaves perfectly erect; whereas A. Nardus grows in rather loose, straggling tufts, and the leaves bend over. As cultivated in Ceylon, A. Nardus often rises to a height of 6 or 8 feet.

Oil.—The leaves are distilled with water, and yield over 3 ounces of essential oil from 1cwt. The pure oil is thin and colourless, with a strong aromatic odour, and an acrid, citron-like flavour. The average exportation of *citronella* from Colombo is about 40,000lbs., valued at £8,000.

Cultivation of the grass and distillation of Citronella Oil.: In Ceylon the citronella grass is raised from seeds, and planted like Guinea grass, and will give two or three crops a year. When fit to cut, the grass is carried to a large boiler and the oil is distilled. It is estimated to give about three dozen bottles of oil to the acre, but the demand is limited, and the price fluctuates from 2/6 to 4/6 per bottle. At the latter price it pays handsomely, while at the former, it little more than covers expenditure. A Still, capable of turning out a dozen bottles a day, costs £300.

Medicine.—The essential oil of *citronella* is regarded as officinal by the Indian Pharmacopœia. In its properties it closly approaches that from the "lemon grass."

Paper Fibre.—In extracting oil from the grass, it is boiled or subjected to steam, under pressure, and as this is one of the first operations to which the raw material is subjected in paper manufacture, grass which has thus been treated should be much more easily utilised than material not previously boiled. Citronella grass, like Esparto, can be supplied entirely free from knots, which is a great advantage in paper manufacture.

KOLA NUT.

Dr. P. Preuss, Director of the Botanical Gardens at Victoria, German Cameroons, West Africa, who has lately been on a visit to Jamaica, informed us that the Kola grown here is the *Cola vera* referred to below, and is very much finer than any he has ever seen in Africa. Hitherto our Kola has been referred to *Cola acuminata*, which is, apparently, quite a different tree.

The following note* on the subject may be of interest to cultivators of Kola in Jamaica.

W. H.

"The kola nuts in commerce have for some time puzzled botanists and pharmacognosists on account of their variation in colour and form. Evidence has not hitherto been forthcoming to show whether these

*E. L. Holmes, F.L.S., in the Pharmaceutical Journal, 23rd June, 1900.

seeds are the produce of different species, or of varieties of one species, and the literature on the subject has to a certain extent been overlooked. Dr K. Schumann of Berlin, who has recently investigated the matter, and has written a monograph on the genus *Cola*, has divided that genus, which now comprises thirty species into sub-genera. He includes the kola nut in his sub-genus *Autocola*, which is characterised by the stamens, or rather sessile half-anthers being arranged in two rows one above the other, and not in a single row as in the majority of species.

Dr. Schumann describes the fruit of *Cola acuminata* as having a fleshy yellow pericarp, with an odour resembling that of Maréchal Niel rose, and containing four or five large seeds. The seeds have a white testa, which becomes brown when the fruit dehisces, and they become exposed to the light. The embryo consists of four cotyledons, of a "carmine" red colour, which when separated, present a triangular, or externally a convex form. These remarks apply to the kola nut brought to Germany from the Cameroons.

Examination of specimens of the kola plants in the Herbarium of the Botanical Museum at Berlin showed that one plant from Ashanti, collected by Cummins, and another from Sierra Leone, collected by Afzelius, differred from the true *Cola acuminata* in having the stigmas broad, obtuse, and closely pressed to the ovary. Specimens of the kola nut with two cotyledons obtained direct from Togoland, and of the tree yielding it, proved to Dr. Schumann that the kola nut of commerce having two cotyledons is the product of the tree having obtuse appressed stigmas, and not of *C. acuminata*, which has pointed, free, curved stigmas. This new species he has named *Cola vera*. It has seeds also of a carmine red colour when fresh. But the two seeds germinate in a totally different manner. In the one, *C. acuminata*, the four cotyledons spread open and the plumule grows up in the centre; in the other, *C. vera*, the two cotyledons remain closed, and the plumule arises outside them.

These two are not the only species yielding edible seeds. The *C. lepidota*, Schm, which belongs to the same sub-genus, having the anthers in a single row only, but seeds with two cotyledons, and another species used by the Bali people, are also eaten. How much these different seeds vary in the amount of the caffeine and theobromine they contain has not yet been ascertained, but the seeds of *Cola vera* are the most highly prized. The large leaf in which they are wrapped is identified as that of *Cola cordifolia*.

The two different kola seeds above described were noticed as long ago as 1860. C. Barter, in his account of the plants found during the Niger Expedition, given in the Journ. Linn. Soc. IV., p. 19, states that there are two kinds of kola nuts, one with four cotyledons, called "Fatak" by the Foulahs, and the other with two cotyledons, called Ganja, by the same people. The latter were said to come from the Ashanti Country, but he had not seen the tree. The species with four cotyledons he had seen at Fernando Po, and in many parts of the lower Niger, abundant at Onitsha, occurring also at Prince's Island, and apparently common along the coast, the flowers being variable in colour, cream-coloured, greenish yellow and pale red. The seeds appeared to be carried in about equal quantities into the interior, but the one with two

cotyledons (Ganja), in the Nupe Country is worth about 100 cowries whilst the other (Fatak), averages about 80 only. The value of cowrie, at Rabba was 2,500 for the dollar of 4s. 4d.

SEEDLING CANES.

By T. J. Harris, Asst. Superintendent, Hope Gardens.

The raising of seedling sugar canes has of late excited a good deal of interest throughout the West Indies, due perhaps, to the possibility of a variety being produced that would yield a sufficiently large average per acre as would solve the difficulty that over-hangs the industry at the present time.

Although Barbados and Trinidad have been eminently successful in raising large numbers of seedling plants, yet it has fallen to the lot of Demerara to give to the sugar planter a variety far superior to any that existed before.

This variety, No. 95, yields under fair conditions, two tons of sugar per acre, and one instance is recorded of its having produced four tons per acre.

It, however, has one draw-back; and that is, the top is so light that the estate cattle, depending as they do on the tops for their food, have to go short, or be fed on Guinea grass. At Hope Gardens, No. 95 is being propagated as fast as possible for distribution among the planters in Jamaica, and large numbers of tops have already been sent out.

To raise canes from seed is apparently no easy matter; repeated attempts were made at Hope during the last four or five years, and not until this year has success been attained; the erstwhile failure being due probably to the difficulty of obtaining definite information on the subject.

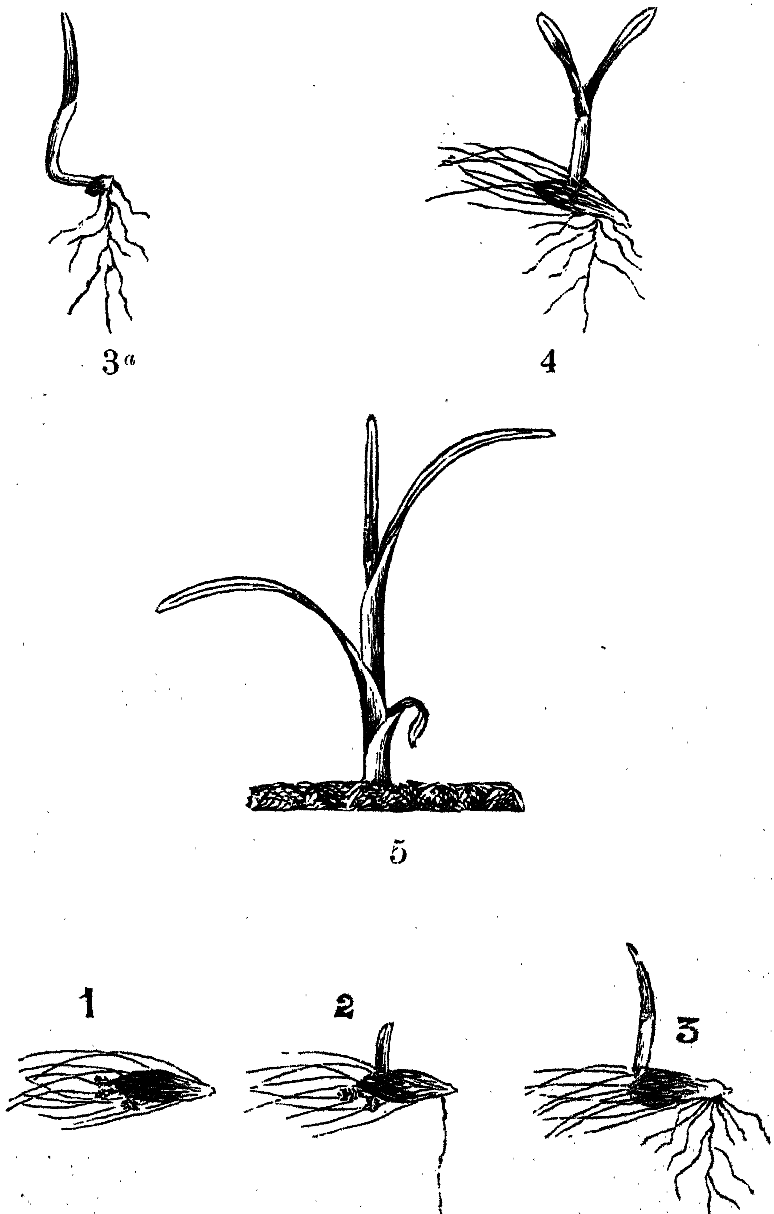
It is with a view to supplying this deficiency that I am tempted to place on record the following notes and observations taken while the seedling canes were being raised at Hope

In the first place the seeds must be perfectly ripe before the "flag" is cut from the cane; the best way to test them, I find, is to bend down a "flag" and blow upon it; if a few of the seeds, with their woolly pappus-like covering are blown away, or if it is seen that some have already been blown away by the wind, then the "flag" may be cut.

The ripe flags are then packed in paper and taken to a closed shed away from the wind, where the seeds are picked off the branches of the flag; these are sown at once in well drained and shallow boxes containing fine sand and a little ordinary soil mixed with it; the surface of the sand is made as level as possible before the seeds are sown, the latter being covered to the depth of $\frac{1}{8}$th of an inch; the boxes are then placed under a glass roof, out of the reach of heavy rains and intense sunlight, and watered carefully.

Fig. 1. indicates the appearance of the seed when sown.

Fig 2. shows the first stage of germination 14 days after sowing; the first leaf appears about a week later; and, as will be seen in *Fig. 3*, emerges from a whitish sheath; this leaf is almost tubular in form and differs in this respect from the surrounding grass weeds. A fairly strong lens is required to distinguish them, and the weeds are, of course, removed as soon as possible.



(1) Seed. (2) 14 days after sowing. (3) 21 days after sowing. (3a) The same, but with the glumes removed. (4) 30 days after sowing. (5) 42 days after sowing.

[All enlarged three times.]

Fig. 3a. represents the seedling in the same stage, but with the glumes removed.

At thirty days from sowing a second leaf is developed' *Fig. 4*; and two weeks later the now strong and quickly growing seedlings are potted into bamboo pots (*Fig. 5.*) in ordinary soil, and kept in a cool and moist place for eight or nine days; after which they are gradually inured to the strong sunlight. After six weeks stay in the bamboo pots, the seedling canes are ready for planting out in the field. Trenches are dug three feet apart, and the bottom forked up and mixed with very rotten cow manure; the plants are then set out at a distance of three feet apart in the trenches and watered and mulched immediately after.

The plants at Hope are now over six feet in height, and were planted out in April of this year.

At first, one stem is formed; and later, when this has reached the height of 1′ to 1½′, offshoots start from the base and eventually catch up to the first one.

About 10 to 14 of these offshoots are formed before any of them begin to ascend, and then all the canes on the "stole" develop together.

The seeds collected from No. 95, have yielded 12 plants, all of which have characters quite distinct from each other; one of them is an exact counterpart of the parent, whilst another looks exceedingly promising, showing fine dark-purple, long-jointed canes, with heavy tops, small nodes, and no "itch"; some of the others appear to be quite worthless; the canes being no more than an inch in diameter, and about 2′ 6″ in height, more or less.

The seedlings raised from the No. 115 cane are not yet sufficiently developed for comparison. They all seem busy making up the stole or stool.

Now that it has been proved that seedling sugar canes can be raised in Jamaica, it would be well if some planters in each district were to sow a few seeds every year; by this means a large number of seedlings would be raised under many diffierent conditions of climate, soil, &c., and from a great many different parent canes, and in this way varieties would be produced from which selections could be made for analyses.

It appears to be of very little use to attempt to systematically cross-fertilize the varieties of sugar cane with a view to combining the characteristics of the parents; repeated attempts have been made in the other West Indian Colonies, but so far without succees; it has, however occurred to me that a fair measure of success might be attained if each planter would save some tops of two goods varieties that are known to flower at the same time, mix them together, and plant them in an isolated spot on the windward side of the estate; where they would grow and flower together; some of the seedlings raised from these would in all probability show improvements on both the parents, and it is more than likely that at least one would turn out to be superior to the best on the estate, or perhaps in the Island; fortunate will be the planter who secures the first improved variety.

EVAPORATION OF WATER THROUGH PLANTS.

In some trials and measurements reported in the *Louisiana Planter* to have been made at Utah Agricultural Experiment Station, it was found that clover evaporated water equivalent to a rainfall of 29¾ inches, and that corn mealies evaporated 25 inches. These quantities being collected by the roots from the soil and subsoil, and evaporated through the leaves.

"Professor Heffriegel estimated that 330 tons (sixty-six thousand gallons) of water are absorbed by the roots of clover, drawn up through the stems and evaporated through the leaves for each ton of clover harvested. Referring to alfalfa (lucerne), it is stated that it is not unusual to irrigate alfalfa every two weeks and to spread an amount of water over its surface during the period of its growth equal to a depth of 6 feet. A portion of this water sinks into the subsoil and may flow off as seepage water; the second part is evaporated and the remainder, perhaps one-third of the whole, passes through the tissues of the plant and is mostly transformed into vapour at the leaves."

It is well to remember that weeds absorb water from the soil as well as the plants of the cultivated crop, thus not only choking them, but wasting the moisture of the soil as well.

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Gardeners' Chronicle, July 28. Aug. 4, 11, 18. [Purchased.]
International Sugar Journal, August. [Editor.]
Journal of Botany, August. [Purchased.]
Journal R. Horticultural Society, August.
Nature, July 26. Aug. 2, 9, 16. [Purchased.]
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Ceylon.
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Central African Times, June, 9, 16, 23, 30. July 7. [Editor.]
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Agricultural Gazette, July. [Editor.]

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Trinidad.
Proc. of Agri. Society, June 12. [Secretary.]

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Provincial Government Crop Report, July, 1900. [Sec.. of Agri.]

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Publications of the U. S. Dept. of Agriculture.

Scientific Bureaus and Divisions. [Directors.]
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Experiment Stations.
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24 (1. Cattle Feeding. 2. Crop Tests.)
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Botanical Studies, Minnesota, Pt. IV. August. [State Botanist.]
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American Journal of Pharmacy, Sept. [Editor.]

SOUTH AMERICA.

Boletim da Agricultura, S. Paulo, Brazil, 1a Series No. 1. [Sec. of Agri.]

SEEDS.

From Laurence Tate, Esq.
Pimento.
From Messrs. J. & J. B. Machado.
Jamaica Tobacco.
From Govt. Bota-ic Garden, Saharanpur.
Apricot
Berberis aristata
" Lycium
" nepalensis
Cestrum aurantiacum
" " (yellow flowered)
Coriaria nepalensis
Cryptomeria japonica
Cudrania javanensis
Dahlia, double mixed
Debregeasia hypoleuca
Deeringia celosioides
Dendrocalamus strictus–nearly solid Bamboo
Dioscorea sp.
Engelhardtia spicata
Hypericum cernuum
" patulum
Myrica Nagi (Fruit edible)
Oenothera Lamarkiana
Piptadenia oudhensis (Oudh Forest)
Pieris ovalifolia
Premna mucronata
Prunus Puddum (Wild Himalayan Cherry)
Pyrethrum frutescens (Shrubby Pyrethrum)
Rhamnus dahurica
Rubus ellipticus (Yellow Himalayan Raspberry)
Smilax maculata
Viburnum cotinifolium
From Botanic Gardens, British Guiana.
Thrinax excelsa
Pritchardia pacifica
Verschaffeltia splendida
From T. J. Breakspeare, Esq.
Lettuce seed.

PLANTS.

From John Barclay, Esq.
Pine Suckers—" Sam Clarke."

[Issued 4th October, 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] NOVEMBER, 1900. Vol. VII. Part XI.

MANURING.

By W. R. Buttenshaw, M.A., B.Sc.

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Plant food is found to be composed of compounds of some twelve elements. All these, with the exception of three—carbon, hydrogen, and oxygen, are obtained from the soil. A fertile soil contains compounds of all these elements, while an exhausted soil is deficient in one or more. The elements that are liable to be deficient are Nitrogen, phosphorus, and potassium. Manuring, therefore, aims at returning to the soil substances containing one, or more, of these three elements.

The fertility of a soil depends, however, not only upon the presence of these substances, but also upon *the state* in which they are present. To be available to the plant they must be in such a state that they can be dissolved, either by the water in the soil, or, by the acid sap that is excreted by the root-hairs of plants. The small amount of plant food which is in this available state would very soon be exhausted, were it not that changes are constantly occurring in the soil, which result in the conversion of the unavailable, or dormant, plant food into an active or available form. These changes are greatly aided by the thorough cultivation of the land, which allows the atmosphere to exert its powerful influence, as they consist for the most part in rendering insoluble compounds more soluble by their union with oxygen.

Unfortunately, this conversion is unable to keep pace with the removal of available plant food by crops. The constant removal of produce from the land causes the supply of available forms of one or more of the elements to fail, whereupon the land is said to to be exhausted. But it must be remembered that it does not follow that these three elements are entirely absent; they may be present in an unavailable state.

A clear idea of the effect which the removal of produce has upon the fertility of the land will be obtained, if a comparison be made between natural vegetation and man's cultivation of the land. In the former case, the plants that grow on the land are either eaten by animals, or are allowed to die and decay where they grew. Whether

it be by means of the animals' refuse or by the decay of the vegetation, the material which the plants have taken out of the soil is returned to it; nothing is permanently removed.

Further, this decay causes an accumulation at the surface, of plant food that has been brought up from below, where the roots have been feeding. This accounts for the large return from virgin forest land. That the fertility of such land very soon declines after being brought under cultivation, is the experience of every planter. There are several reasons for this. First, the working of the land causes oxidation. The supply of oxygen, that the air carries into the soil, enters into combination with the accumulated organic matter, or humus, causing some of it to become more soluble, some to be converted into gases. The soluble matter will be used by plants or be lost by drainage; the gases will escape into the atmosphere. The second result of cultivation is that a better system of natural drainage is secured by means of which much soluble matter will pass out of the soil in the drainage water. But the source of loss which is most considerable, lies in the *permanent* removal of produce from the land for market and export purposes. Regarding the matter from the point of view of the soil's fertility, we can imagine an almost ideal state of affairs—that is when the whole of the produce of a property is consumed *on* the property, and all the excrement of the consuming animals is returned to the soil In such a case the decline in fertility would be reduced to a minimum. Such a system is not expedient for the simple reason that most cultivators aim at supplying produce on a larger scale. It is, then, chiefly this permanent removal of produce from the land that causes the fertility to decline. Common justice calls for some return for this removal. The loss is greatest in the case of the cultivation of such plants as are grown for their *whole* structure, when practically the whole plant is removed, as, for example, cabbages, and guinea-grass, when cut.

On the other hand in the cultivation of many fruit trees the bulk removed is far less. In the case of such crops as yams, the main bulk of the plant *need* not be removed from the soil, though in too many cases the "vines" are burnt. Such an unwarrantable waste of plant food cannot be condemned too strongly. The cultivator of new land should bear in mind that his land will soon fail to give him good returns, if he does not give it a reasonable chance. He must endeavour to keep up the fertililty as long as he can, and he can do so in several ways. Thus, he must return to the soil as much as possible of what he takes out of it. The useless, or rather unmarketable, portions of the crop should be allowed to decay in the soil. Such substances, though not immediately available to the plant, will increase the amount of plant food in the soil and will gradually become more and more available. They will by reason of their decay also exert indirect influences for the good of the soil

Exhaustion of the soil can be still further postponed by a judicious succession of crops. Nothing exhausts land so rapidly as the growing of the same crop season after season. It must be remembered that every crop removes from the soil *one* of the elements of plant food to a greater extent than the others, Thus corn removes nitrogen in greater quantities than it removes phosphorus and potash, while

tobacco is a potash-feeder. By adopting a system of rotation of crops, these elements are removed from the soil *in turn*; so that while the crop succeeding a nitrogen-feeder is removing chiefly potash or chiefly phosphorus, the soil has a chance of recouping its available supply of nitrogen by allowing its dormant supply to be rendered available. In this way the conversion of dormant into active plant food is enabled to keep pace with the removal by the crop of the available matter.

Though it has been indicated how the land can, by rational and thorough cultivation, be kept fertile and prevented from becoming exhausted, it must be admitted that circumstances do arise, which make it necessary that something be added to the land to increase its fertility.

Any substance added for this purpose is a manure

Now as the fertility of the land depends not only upon the presence of plant food, but also upon the state in which the plant food exists, it follows that there are two ways of increasing the soil's fertility. One, by adding to the store of plant food in the soil, the other—an indirect method—by increasing the amount of available plant food by acting upon the dormant. Hence a manure can be placed into one of two classes, according to whether it acts directly or indirectly. Thus, lime is usually regarded as an indirect manure, since it acts upon the dormant potash, causing an increase in the amount of potash at the disposal of the crops. A direct manure, therefore, is one which *adds* plant food to the soil, It may add all the necessary elements required by the plant in which case it is called a *general* manure; or it may be a *special* manure, supplying only one or two of them, as in the case of many of the artificial chemical manures.

Stable Manure.—The best example of a general manure is that which has long been used under the varying names, Farmyard, Stable and Pen Manure. The name it goes by matters little. Its value as a substance that increases the fertility of the soil, must be appreciated. It is made up of the excrement, solid and liquid, of all the animals kept on a pen or estate, the refuse of livery and other stables, together with trash of some sort used as bedding. On most estates, some, at any rate, of the stock are kept in fenced enclosures, or in stables It is in such cases that there is some accumulation of manure, and that the proprietor has to consider its application to the land. Since this manure is the refuse of plant-consuming animals, the cultivator by its use enriches the land in *all* the constituents of plant food. For this reason stable manure is par excellence a *general* manure. No opportunity should be lost, therefore, of using not only all that is produced on the property, but also any that can be obtained at a reasonable cost. In many parts of Jamaica there is certainly a difficulty in obtaining it; but in other districts the constabulary and other owners of stables are obliged to pay for the removal of their dung, so slight is the value placed upon it. Where stable manure can be procured at a cost very little above that of cartage, its use is certainly to be advocated.

It has already been shown that some manures have a direct, and others an indirect action in increasing the fertility. This manure acts both directly and indirectly. The latter action is due to the power possessed by stable manure of improving the mechanical condition of

the soil by its own rotting. By an application of manure, light sandy soils are rendered more retentive of water, and hence better able to produce crops : while on the other hand, stiff clay land becomes more porous through the escape of the gases which result from fermentation, in much the same way as dough is lightened by yeast. The opening of a clay soil results in a better circulation of air, which causes dormant plant food to be rendered available by oxidation.

It must, however, be remembered that the composition, and consequently the value, of stable manure varies very considerably. Thus the amount and nature of the material used for litter will cause the quality to vary, some forms of litter absorbing much more of the urine than others. Also the composition will vary according to the age and kind of animal producing it; for the dung of young growing animals is not so valuable as that of the same animals when full grown. But nothing causes manure to vary so much as the treatment to which it is subjected. There are so many ways in which it can deteriorate. Much of its value may be lost by allowing the urine to drain away, or the soluble matter to be washed out by rain. This shows that keeping manure too long before using it renders the owner liable to great loss. If stored it must be protected from rain. Again, manure very readily ferments, and the fermentation that goes on in a heap of it results in the production of great heat and also of ammonia gas. If proper care is not taken, the heat may be sufficient to cause ammonia compounds to be volatilised, whereby the most valuable constituent of the manure—the nitrogen—is allowed to pass into the atmosphere. The heap must, therefore, not be allowed to become too hot; and if the well-known odour of ammonia be recognised, it must be dampened, and a layer of earth placed over it to absorb the escaping gases.

The mode of application is of no less importance than the treatment. Questions are constantly being asked, which show that agriculturists are in doubt as to how the best results can be obtained, such questions as whether the manure should be applied in a fresh state or after it has been well rotted, and whether it should be applied on the surface or dug into the land. Owing to the varying conditions of soil, crop, and season, it is almost impossible to lay down hard and fast rules. Much therefore must be left to the discretion of the cultivator. But there will be much less risk of his erring, if he bears in mind the following points :—

(a.) when it is stored there is danger of loss by leaching and by destructive fermentation, this danger being removed if it be applied fresh;

(b.) since during decay the food material becomes more soluble, rotten manure will be made use of by the plants much sooner than fresh dung;

(c.) decay takes place more slowly when the manure is dug in than when it is spread over the surface and exposed to the action of the atmosphere;

(d.) fresh dung, owing to the heat produced on fermenting, is unsuited for use when planting young trees.

Arguing from these data, it follows that—

(i.) if it be on account of its *direct* action that the manure is being used, and if an *immediate* return be required, rotten dung, containing a larger proportion of available matter, should be used;

(ii.) if the main object be the improvement of the mechanical condition of the soil, then fresh, unrotted manure should be applied in order that the *full* benefit may be obtained;

(iii.) in wet weather manure should be applied fresh to minimise the risk of loss by drainage, and should at such a time be dug in rather than be placed on the surface;

(iv.) in the case of the planting of young trees, the planter should either use well rotted manure or apply the fresh manure three or four months before planting;

(v.) when it is to be applied to fruit trees, the cultivator will find it advisable to place it in the form of a mulch, that, in addition to feeding the roots, it may help to conserve soil moisture.

Green manuring.—The growing, for manurial purposes, of a leguminous crop constitutes another method of increasing the supply of humus in the soil and of *all* the constituents of plant food. For this purpose a crop is grown and dug (or ploughed,) in as it stands One of the leguminous crops, e.g., cow pea or velvet bean, is chosen because of the power possessed by these plants of fixing the atmospheric nitrogen and storing it up in the form of compounds in the small swellings on the roots. Digging such a crop into the soil will therefore, besides increasing the amount of humus, return all the plant-food removed from the soil, adding at the same time a quantity of nitrogen obtained from the air, but in a form suited to the requirements of plant life Many small cultivators, who are in the habit of growing red peas for the market, are unfortunately so ignorant of the special property of these crops, that they pull up the *whole* of the plant to obtain the pods! This trash is often burnt. After the removal of the pods, the rest of the plant *ought* to be dug into the land, that the fertility instead of being decreased, may be actually increased.

Since plants, with the exception of these pod-bearers are able to take in nitrogen only in the form of nitrates, or salts formed from nitric acid, these manures have to undergo various changes before the nitrogen is available to plants. A most important change is that known as *nitrification*, which consists in the conversion of the ammonia, produced by the decay of the manure, into nitric acid, and the combination of this with lime or potash to form soluble nitrates This process is constantly going on in fertile soils, and is due to the action of bacteria. The planter can help on this action by seeing that his land is properly ventilated —an essential condition of nitrification—and well supplied with lime. Nitrates will be formed also in a heap of decaying animal and vegetable matter, if the heap be mixed with lime and watered with liquid manure, care being taken to loosen it at frequent intervals to allow the air to enter. By this means most of the estate refuse can be utilised as manure.

Seaweed may also be regarded as a general manure, in that it supplies all the constituents of plant food; but since of the three chief

constituents only the potash is in readily available form, it must be regarded mainly as a potassic manure, and one to be used for potash feeding crops. Hence its application to Irish potatoes has been found to give an increased yield. In its indirect action it can compare very favourably with stable manure. On account of its ready decay, it increases the supply of humus in the soil, and has been found to improve light sandy soils. It can also be used with advantage as a mulch. The cultivator of land near the coast will find it well worth the cost of carting it on to his land, especially if he supplement it with some available nitrogen and phosphorus, in the form of fertilisers, to render it a more perfect *general* manure.

Guanos.—These manures form a bridge, as it were, between the general and the special manures. Guanos vary much in composition and though most of them contain all the manurial constituents some of them may be classed as special manures, because they contain one of the constituents in greater prominence. Thus some are said to be nitrogenous and others phosphatic, that is, guanos with high percentages of nitrogen and phosphorus respectively.

Special Manures.—Since special manures are those containing only one or two of the constituents of plant food, it is most convenient to classify them according to which of the constituents they supply; we therefore have three groups, (i) *nitrogenous*—*i. e.*, supplying nitrogen; (ii) *phosphatic*—*i. e.*, supplying phosphorus; (iii) *potassic*—*i.e.*, supplying potash. A few remarks on the nature and action of the important and best known special manures may serve as a guide to their use in restoring the fertility of the soil.

(i.) *Nitrogenous Manures.*—As the general tendency of these manures is to produce a large amount of leafy growth, care must be taken lest a too liberal application damage the yield of fruit *Nitrate of Soda* is of all manures the quickest in action. There are two reasons for this. It is a very soluble compound, and, further, it contains its nitrogen in the *right form* for immediate absorption by the roots. These very properties call for great care in the use of the nitrate, for on account of its solubility, it is very liable to be washed out of the land by rain. It should only be applied at a time when the crop is in a state of active growth and there is no probability of heavy rain. *Sulphate of Ammonia*, which is a waste product in the manufacture of gas from coal, is the great rival of nitrate of soda as a nitrogen supplier. It has the advantage of being more readily retained by the soil, and there is consequently not the same risk of loss by washing. It is not so quick in its action since it is not ready for immediate absorption. The ammonia has to undergo conversion into nitrate. Lime being necessary for this process of nitrification, sulphate of ammonia should never be applied to soils deficient in that constituent.

(ii.) *Phosphatic Manures.*—These are the manures whose effect will be most noticeable on fruit trees. Their tendency is to increase the yield of fruit and to hasten ripening. It should be remembered that phosphorus occurs in soils and fertilisers usually in the form of compounds, known as *phosphates*. For the most part, these compounds are very insoluble, and this causes the plant to experience considerable

difficulty in obtaining a sufficient supply. The acid sap of the roots is necessary to dissolve these phosphates, though the carbonic acid gas produced by the decay of vegetable matter, assists in their solution. In some forms, then, of phosphatic manures, the phosphate is in a much more soluble state than in others. Hence the purchaser should always insist upon an analysis stating the proportion of phosphate which is *soluble*. *Bones* are the oldest special manure of any kind in use. They were first applied in inch or half-inch pieces; later they were ground to a powder. In either case they were a long time in coming into use on account of the insoluble nature of the phosphate they contained. It was found that fermenting—by making a heap and watering with urine—rendered them more readily available. The phosphate of *steamed bones*, i.e. bones which have been steamed in order to remove their gelatin for glue-making, is also more soluble than that of raw bones. The conversion of insoluble into soluble phosphate is brought about most completely by dissolving the bones in sulphuric acid. This process is the basis of the manufacture of *superphosphates*.

As the supply of bones for such purposes is necessarily limited, superphosphates are now more frequently made from what are known as *mineral* phosphates. These are of two kinds, viz., the rock phosphate found in Canada, and coprolites, which are little lumps of fossilised dung. The latter are mined in many parts of the world, e.g. in several of the West Indian Islands. These hard insoluble masses are ground and treated with sulphuric acid, when they yield a manure composed chiefly of soluble phosphate.

(iii) *Potassic manures.*—Since the production of sugar and starch by plants causes the removal of potash from the soil, sugar, and starch-producing crops should receive potassic manures. This accounts for the increase in yield of Irish potatoes in land that had received an application of sea-weed. Similarly, it has been found in Jamaica that wood ashes improve the quality of oranges, that is to say, make them sweeter. In a country where so much wood is used for fuel, there is scarcely any necessity for buying potash fertilisers. Wood ashes contain a fairly high percentage of potash in a readily available form. In the United States wood ashes are an article of commerce, the price per ton varying from 10 to 12 dollars. This fact should suggest to the cultivator in Jamaica the value of the ashes from his kitchen and the desirability of making use of them. He must, however, be warned against allowing them to be washed by rain By leaching, wood ashes, like stable manure, lose all their soluble matter. Ashes may with advantage be applied to tobacco and leguminous crops.

Growers of tobacco have at their disposal another potash manure. Tobacco stalks are rich in this constituent and should always be returned to the soil. If potash in an *available* form be required, the stalks should be burnt; otherwise they should be allowed to rot in the soil, thereby adding also a small amount of nitrogen.

Kainit is the chief chemical fertilizer supplying potash. It is obtained from the huge salt mines of Germany, and can be placed on the market at a low price.

Indirect manures.—It has been shown that substances like stable manure, besides adding plant food to the soil, have an indirect action

in increasing the amount of available plant food. Some manures, on the other hand, exert mainly, if not entirely, an *indirect* action. Such a manure is *Lime*. Although lime forms part of the food of plants, the amount required is so small that practically no cultivated soils do not contain sufficient to supply the immediate needs of their crops. For this reason it is considered that the good effect of an application of lime to most soils is due entirely to its indirect action. Lime affords an excellent example of the different ways in which the fertility of a soil can be increased *indirectly*. Lime exerts a mechanical effect upon the soil. It improves the texture of clay land by removing the stickiness, thereby rendering it powdery and more readily acted upon by the atmosphere. A simple experiment will demonstrate this action.

Take a quantity of stiff clay and divide it into two. With one portion mix a little lime, and make both portions up into a stiff paste. Leave in the sun to dry. When dry, note that the portion that received no lime is very hard and 'cakey' while the other crumbles down when touched. Applying this principle to practice, it will be seen that if clay land be well limed, the atmosphere will have a much better chance of doing its work. On the other hand, when lime is applied to light sandy soils, it acts as a cement, binding the coarse particles of sand together. This accounts for its use in making mortars

The other effects of lime are of a chemical nature. (i) *Lime frees potash*. The potash in the soil is bound up in very insoluble compounds, upon which the lime is able to act chemically, turning out the potash and placing it, as it were, at the disposal of the crop (ii) *Lime helps on the decomposition of vegetable matter* by securing the best conditions for fermentation. (iii) *Lime sweetens sour land* by counteracting the acids produced by the decay of vegetable matter. If these acids accumulate, as they will in a badly drained soil, the land becomes sour; this sourness can be removed by an application of lime. (iv) The presence of lime in the soil, as has already been stated, is a *necessary condition of nitrification*.

Lime can be applied to the soil in several forms. Marl and chalk spread over the soil produce good results, but the form most suitable for application is slaked lime which has been exposed to the atmosphere for some time. When limestone or chalk is heated in a limekiln, carbonic acid gas is driven off, and the substance left is *quicklime*. This form is unsuitable for application to the land on account of its caustic nature. It is readily converted into slaked lime by adding water. Slaked lime is still somewhat caustic and apt to cause the burning up and loss of organic matter. Therefore slacked lime should be exposed to the air; carbonic acid gas is absorbed, and the substance formed does not differ in composition from the original limestone, but it is in a powdery condition convenient for application. Deficiency of lime in a soil is usually due to its tendency to sink. This should be a guide to the cultivator in applying it. Lime should be kept as near to the surface as possible, and therefore spread over the land rather than dug in. Although lime is insoluble in pure water, rain water has sufficient carbonic acid gas in it to dissolve it, and when dissolved the lime must percolate downwards, since it is not absorbed by the plant roots. Other salts, much more soluble than lime, also pass into solution, but they

are thereupon taken up as plant-food, and thus prevented from sinking.

Common Salt acts as a manure in a similar manner to lime. Since neither of its constituents—sodium or chlorine—seems to be among the essential elements of plant food, it is regarded as an indirect manure. Like lime, it has a chemical effect on the insoluble potash compounds, freeing potash for the use of the plant. It also improves the texture and drainage of clay land. It has been found to be a good manure for sugar cane when grown far from the coast. The effect of common salt is however to increase rather the quantity than the quality. Thus it spoils tobacco, while it increases the yield of cabbages. Whereas lime can be applied at the rate of one ton per acre, not more than 200 lbs. of common salt should be given to an acre, for it is a powerful antiseptic, destroying all germ life.

In this article no attempt has been made to do more than give a general outline of the principles of manuring and the nature and action of the manures most frequently used. To recommend, with any hope of success, the kind and quantity of manure for individual crops is practically impossible. Many conditions have to be taken into account, the nature of the soil in particular. The aim of special manuring is to supply what is deficient in the soil and also to help the crop to obtain *that* ingredient which it experiences special difficulty in obtaining, Although it must be regarded as the work of chemists and experiment stations to ascertain the general food requirements of crops, the cultivator must not expect to obtain all the desired information second-hand. There is much that he can do for himself with little trouble and at a comparatively small cost. Every cultivator should arrange for himself a series of experimental plots, in which he can test the results of different manures. The experiments can be so arranged as to test the effect of nitrogenous, potassic, and phosphatic manures alone, the effect of mixtures containing two or three of these constituents, and also the effect of the different forms of these manures in which these constituents can be applied Likewise, the experimenter will be enabled to determine the amounts which give the best returns. The results will possess the advantage of referring to land similar to that on which the crops are to be grown. To make them reliable, however, some method must be followed and some degree of accuracy aimed at.

BUDDING ORANGE TREES.

By W. Cradwick, Superintendent of Hope Gardens.

The preparation of Lemon, Shaddock and large Sour Orange Trees for Budding.

Success in budding or grafting any plant or tree depends on the skill of the operator, but also in quite as large a degree on the condition of the stock or scion. The stock is the plant on which the bud or graft is to be placed and which is to become its foster mother. The scion is the bud or graft which is to be placed on the stock, and which is to become the foster child of the stock. In this case the stock referred to will usually be a sour orange, lemon, or valueless shaddock

tree. The scion will usually be the small piece of sweet orange, good grape fruit, or marketable lemon—wood containing the bud which is to grow into the future tree.

Both must be vigorous and healthy, the stock so much so that the bark is thick and soft, and so easily detached from the wood as to render it possible to push the buds under it to their proper position without having to resort to the help of the knife to raise the bark, if this is not so, the bud however good, will rarely grow; if the stock is in the condition described and the buds are not healthy and vigorous, then the operation will probably be a failure.

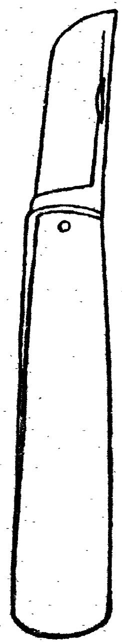
Large sour orange, lemon, shaddock, or other worthless trees before they can be budded, must be cut down to a height of five feet above the ground. They should be sawn level, the cut made quite smooth and covered with a good coating of tar; ordinary coal tar mixed with an equal bulk of grease should be used, as the mixture does not readily crack or peel off in the hot sun.

The proper time to cut down the trees is when it is certain that the seasons' rains, either in October or May, have set in: October for preference, as the trees will then throw out young shoots readily; on these young shoots the sweet orange buds have to be placed.

If the trees send out a large number of shoots, the shoots must be reduced to six, selecting the six strongest nearest the top of the stump, and at fairly equal distances from one another. These young shoots must grow to be about as thick as one's finger or three quarters of an inch thick at the base, before they are ready to be budded on. If the trees are cut down about the beginning of October, this will be about February, which is also the best time for budding, as the buds then start to grow in the fine weather, and the May seasons help them along after they have commenced to grow. If the sour trees are injured, or in poor health from any cause, do not attempt to bud them.

CONDITION OF TREES FROM WHICH THE SWEET ORANGE BUDS ARE TO BE TAKEN.

Sweet orange buds must be taken from young but not soft wood only. The proper sized growths are those about as thick as a lead pencil. The buds must be well developed and plump as shown in the illustration, and if possible should be taken from the round wood only. Buds with thorns attached should not be used, they do not grow so readily, and if they grow result in a tree on which long thorns will be one of the chief features; a tree grown at Hope from a bud with a thorn an inch and a quarter in length attached, produced thorns over eight inches in length. If the tree from which it is desired to take buds have no young growths of this description, the tree should be cut back. If few buds are desired, then only some of the branches need be cut, but if large quantities of buds are required the tree might be cut back all over. Cut back the branches about a third of their length, but not more; this will cause them to send out the young shoots. Unless shoots on both sweet and sour trees are in the condition described, the budding will not be successful



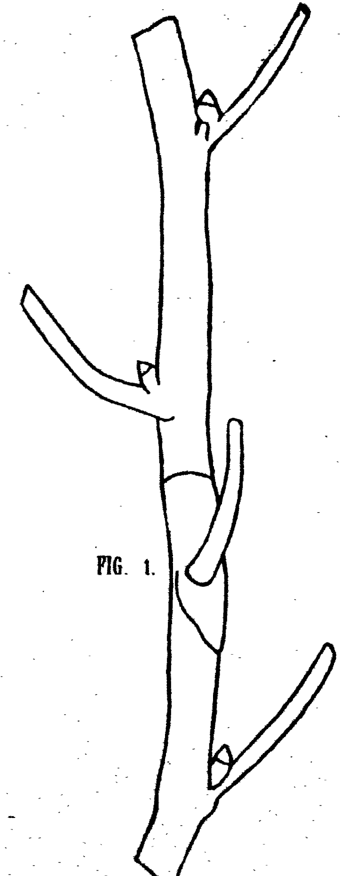


FIG. 1.

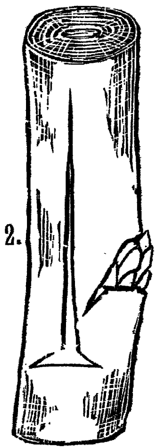


FIG. 2.

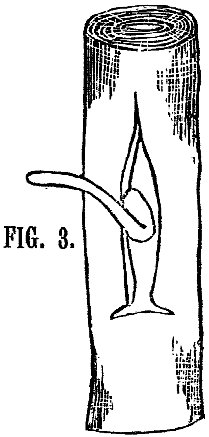


FIG. 3.

Budding is done as follows, as soon as the growth on both sweet and sour Oranges are in the right condition.

Cut one of the young shoots from the sweet tree quite close to the old wood, and then with a very sharp knife cut off a piece of the bark and wood, about an inch and a quarter long, with a bud in the centre, as shown in the illustration (Fig. 1). If a leaf is growing with the bud, cut it off leaving the stalk attached to the bark as shown in the illustration (Fig. 1): never break or pull it off.

The buds at the very base of the shoot on the round wood are the the best so long as they are properly developed and there is the requisite length of bark attached; whether a leaf is growing on the joint, or not, does not matter in the least, except that it is so much more convenient to be able to hold on to the leaf stalk when pushing up the bud.

Make a horizontal cut about a third of the way round one of the shoots of the sour orange tree near the bottom, and a perpendicular cut to form the letter T inverted (as shown in Fig. 2). Make the cuts so that the bottom of the perpendicular cut is as close to the bottom of the shoot as possible. The cuts should go clean through the bark, but care must be taken not to cut the wood. Take the sweet orange "bud," that is, the little piece of sweet orange wood with the bud on it, insert the point into the bottom of the inverted T cut—(⊥) and gently push it up under the bark until the lower end of the "bud" is level with the horizontal cut of the inverted T (drawing).

Care must be taken in all the operations that neither the bark containing the bud, nor the bark of the sour shoots is injured, or the operation will probably be a failure.

When the bud is in its proper place at the bottom of the inverted T cut, it must be tied firmly to make it stick close to the wood of the shoot, tying it rather tighter than can be borne on one's finger, and also to prevent the bark of the sour shoot from shrivelling and turning back, leaving the bud to dry up. Knitting wool, or other soft material may be used, but Raphia or budding tape is preferable. The following recipe for making budding tape has been found useful:—

To every pound of bees-wax, add a lump of rosin the size of an egg, and 1½ table-spoonfulls of raw linseed oil. Boil and then dip the tape in.

Take care to cover the whole of the wood on which the T cut has been made, and at the same time not to cover the bud. In wet weather the bud should be wholly covered by the tying material, but the tying should be so done as to allow of the partial removal at the end of eight days to allow the bud to "look out," and at the same time be kept tightly tied to prevent turning back of the bark of the stock.

It is necessary that the trees be inspected every two weeks after budding to be sure that the wood has not swollen so as to tighten the tying material and hinder the flow of the sap. If the shoots swell and cause cutting, the "ties" must be loosened and carefully retied so as not to cut. It must be seen too that the string be renewed if it breaks, for if this should happen, the bark of the shoot will turn back, and the bud will die.

If the bud keeps green for two weeks the shoot on which the bud is placed should be cut back a third of its length. When the bud has

grown about 8 or 10 inches, cut the sour shoot back to within three inches of the bud, always taking care to prevent any of the sour orange shoots from growing, otherwise they will soon become so vigorous that they will take all the sap from the sweet orange buds and leave them to starve. When the bud has grown a foot, cut the sour shoot back close to the top of the bud, so that no buds are left on the sour shoot, above the sweet orange bud.

If the sour tree after being cut back, should not send out shoots near the top, the stump should be cut back to where it is shooting, before the shoots grow too long, or it will be very difficult to tie the buds. Six shoots may be budded on each stump, all shoots not budded must be rubbed off or they will take all the sap and starve the sweet orange buds.

A proper budding knife similar to the one illustrated, is almost indispensable; an ordinary knife may be used, but in any case the blade of the knife should be thin and exceedingly sharp. Use the budding knife for no other purpose, not even to cut off thorns with.

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Division of Vegetable Physiology & Pathology. 22 (Xenia, or the immediate effect of Pollen, in Maize.)

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Arizona. 34 (Timely Hints for Farmers.)
35 (Vegetable Growing in Southern Arizona.)
Florida. 54 (Peccan Culture. A Preliminary Report.)
New Jersey. 144 (Live covers for Country Homes.)
Ohio. 109 (Eighteenth Annual Report for 1898-99.)
110 (The Maintenance of Fertility.)
111 (Investigations of Plant Diseases.)
112 (The Clover Root Borer.)
113 (Plums: A Comparison of Varieties.)
114 (How Insects are studied at the Ohio Agricultural Experiment Station.)
115 (Sugar Beets and Sorghum. Investigations in 1899.)
116 (The Grape-Cane Gall maker and its Enemies.)
117 (Stomach Worms in Sheep.)
Rhode Island. 69 (A Study of Plant Adaptations.)
70 (Analysis of Commercial Fertilizers.)
Texas. 57 (Report of Beeville Station, (No. 4.)
Cabbage—Fertilizers, varieties, shipping.
Cauliflower—varieties, shipping.)
Utah. 68 (Experiments with Dairy Cows.
Part I. A Study of their Records.
Part II. Winter Feeding Experiments.
Part III. Summer Feeding Experiments.)
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SEEDS.

From Botanic & Domain Gardens, Melbourne.

Acacia cultriformis
" cyanophylla
" dealbata
" longifolia
" pycnantha
Callistemon rigidus
Doryanthes Palmeri
Eucalyptus coriacea
" crebra
" foecunda
" macrandra
" pilularis

Melaleuca styphelioides
Homalanthus populifolius
Pittosporum undulatum
" rhombifolium.
Sophora tetraptera
Sterculia acerifolia
" diversifolia
Swainsona galegifolia, var.

From Govt. Botanist, Cape Town.
Schotia latifolia
Leucadendron argenteum, "Silver Tree"
Protea mellifera, "Suiker hoseh"

From S. H. Watson, Esq., Morant Bay.
Sumatra Tobacco seed.

From Royal Botanic Garden, Berlin,
Meliosma Herbertii
" obtusifolia

PLANTS

From Miss Mais, Kingston.
Malpighia glabra

From Botanic Station, Barbados.
6 plants Plumeria—3 varieties

From Messrs. Jas. Veitch & Sons, Chelsea, London
Acalypha Macafeeana
Aerides japonicum
Amaryllis China
" Figaro
" Helenis
" Poirier
Amasonia punicea (dead)
Cattleya aurea
" citrina
" Schroderæ
Cissus porphyrophyllus
Coelogyne Massangeana
Colax jugosus
Croton, Aigburth Gem
" Flamingo
" Gold Ring
" Mrs. Iceton
" Mrs. McLeod
" Reidii
" ruberrimus
" Warrenii
Cyperus alternifolius, variegatus
Dendrobium Bensoniæ
" Cassiopes
" crassinode
" formosum
Dipladenia boliviensis
" insignis
Dracæna, Lord Wolseley
Epidendrum prismatocapum
" vitellinum-majus
" Wallisii
Epiphyllum Russellianum, var. Gaertnerii
" truncatum, var. Lady F. Cavendish
" " var. lateritium
" " var. violaceum
Ficus radicans, variegata
Lælia albida
" autumnalis

Lælia crispa
" peduncularis
" tenebrosa
Maxillaria picta
Myrtus communis
" " var. Jenny Reitenbach
Odontoglossum citrosmum
" Harryana
" hastilabium
" pulchellum
Oncidium cheirophorum
" concolor
" crispum
" divaricatum
" flexuosum
" Forbesii
" incurvum
" macranthum
" Marshallianum
" ornithorhynchum
" phymatochilum
" pulvinatum
" sarcodes
" St. Legerianum
" tigrinum
" varicosum
Phalænopsis amabilis
" Esmeralda
" grandiflora
" Luddemannana
" Schilleriana
" Stuartiana
Phyllocactus Cooperii
" Grand Monarch
Hecla
Jessica
Saintpaulia ionantha
Tricopilia coccinea
Kalanchoe flammea
Vanda cœrulea

[Issued 5th Nov., 1900.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] DECEMBER, 1900. Vol. VII. Part XII.

THE PHILIPPINE HEMP INDUSTRY.

Among the chief industries in the Philippine Islands is the gathering and export of Hemp. Manila hemp is known the world over for its fine quality and its value for making all kinds of rope, from the biggest hawser down to the finest piece of twine, and it would be very much in order to devote a little of our space to this important feature of Manila's commerce.

The scientific name of this hemp is *Musa textilis,* and the tree belongs to the banana famly.

"Manila hemp" is the name invariably used by the merchants of England and America to distinguish it from the Russian and Indian hemp, which is much inferior. In the Philippines, however, it is not regarded as a product of Manila and districts, but chiefly of the Southern islands, and it is called "abaca" with the accent on the last syllable.

The hemp trees of the Philippines have been tried to be introduced in Borneo and India, but without much success. The trees grow best on the Pacific slopes of the southern islands. South Luzon furnishes the best quality and greatest quantity, but there is little difference between Samar and Leyte of the Archipelago as producing districts. The roots of the plants cannot exist in damp soil; volcanic soil, where the ground is dry, and plenty of moisture overhead, is essential to getting the best results.

Here, in these localities, we find large plantations among the hills with the hemp trees in different stages of growth. They require little cultivation; once a week the native cleaner or gatherer goes through the plantation and does the little weeding that is necessary while in performance of his duty of cutting and stripping the trees.

The trees are planted from suckers and grow to a height of ten feet, and from five to seven inches in diameter. In appearance they appear to an unpractised eye like the banana tree, and if these trees were allowed to grow five or six years they would develop a fruit something like a plantain; it is said by some that this fruit is poisonous.

When the tree is three years old, then it is the proper time to cut it down and strip it of its fibre This stripping is a most difficult and important point in the production of hemp and requires great experience. The native cleaner, as he is called, goes up into the hill armed with his bolo and a bag of rice. He enters the plantation and glances to right and left as he walks along. Experience has taught him to tell at a glance if a tree has reached the age for cutting. One slash with the bolo and the tree is cut down close to the roots. The first thing he does is to plant a cutting or shoot in close proximity to where the tree grew. This is invariably the rule, that when a tree is cut down another is immediately planted in its place, so there are at all times trees in different stages of development. As soon as this is done he strips the plant of its leaves and commences on the long stalk eight or ten feet in length. He strips off the extreme outer skin and then commences the real work. In the centre of the stalk is a stout pith, and around this grow alternate layers of fibre and sappy vegetable matter. These layers of fibre must be carefully stripped off the stock at once for fear of them rotting the fibre. The cleaner in a couple of minutes has cut a small bamboo tree and made a rough bench. With a bamboo strip fastened to his knife and that in turn fastened to his foot, he stoops over to the ground in front and then makes a full backward sweep as far as his arms can reach, stripping a layer of fibre which he throws off to one side. This is repeated until the fibre is all taken off, and after spreading the strippings on the ground to dry in the sun, he continues to repeat the work in another spot wherever he may find a tree in the proper state of maturity. The work of stripping is heart-breaking and causes many a lame back; even the native who is accustomed to the work finds it no sinecure. A full tree will yield about one pound of fibre and a native can clean fifty pounds in a week. The length of the fibre is from six to eight feet.

The natives are exceedingly independent and work as long as it suits their convenience. When a cleaner has got what he considers enough fibre cut, cleaned and dried, he ties it up and takes it down to market, where he sells it to the middleman and receives in return the market value of the fibre. The plantation owner receives one-half this remuneration and the native keeps the other, and this is the only time the plantation owner figures in the whole transaction, *i.e.*, when he gets his half. He simply watches to see that he gets his share.

In the hemp ports, representatives from the business houses in Manila buy from those middlemen. They are either Spanish, Chinese or native dealers, who collect the hemp and barter with the native cleaners, using rice as the standard of exchange.

GRADES.

Ordinarily, the hemp arrives here classified according to grade by a middleman, but sometimes it is sent here to be classified and the experienced eye of the merchant spots at once all defective or injured fibre.

The quality depends a great deal upon the original cleaner and the state of the weather at the time the tree was cut.

To turn out the best grade the cleaner must be very careful in his stripping and have the fibre dried at once, whereas, if allowed to stand awhile, the fibre loses its fine colour and some of its strength. Hemp is graded according to fineness or coarseness, colour, length of fibre and its tensile strength. The latter depends greatly upon the age of the tree. The colour and coarseness show the quality of the Hemp and this depends, as mentioned above, wholly upon the cleaner. Sometimes he is careless, and more especially when high prices prevail in Manila he does not trouble himself about the quality of his work, but aims only to turn out as much as possible while the market condition prevails.

VALUE.

The value of hemp varies. It has been known to be as high as £60 per ton and then again as low as £14 sterling. Of late the price has fluctuated continually, owing to the war and the political situation in the Philippines. The average rate per ton, however, is about £25 or £30 sterling.

There are between 800,000 and 1,000,000 bales of hemp produced and shipped from this island annually. The United States, acting as a centre for South America, Cuba and Canada, and England as a centre for Europe and Western Asia, take the bulk of the trade in about even quantities.

The bales are packed by both hand and steam presses and weigh about 28 pounds each. They are thus conveniently handled. About half a dozen of the shipping houses here do the bulk of the export trade and, perhaps, forty steamers are utilized in the carrying of rice to the ports and a return cargo of hemp to Manila.

The handling of the business requires years of experience and a long residence in the country, to be successful in coping with the business methods of the wily Asiatic, both Chinese and Filipino.

We all remember how in visiting the owner of an orchard he takes us through his fruit preserves and can tell every grade and variety of apple tree. They appear to the unpractised eye to be all apple trees. It is the same with the hemp plantation. There are many varieties and the natives showing a visitor through the groves points out the different grades of trees, giving its native name and whether the quality is better or inferior to the ordinary. There are residents here in Manila, foreign as well as native, who from long experience in handling hemp, can at a glance judge which ports certain bales of hemp have come from. It is indeed a great business and cannot be learned in a day.

From the outer layer of a properly matured tree comes the finest of fibre, and if this is carefully cleaned and dried, it is sometimes used by the natives to weave into cloth. They mix it with silk and make a sort of Indian muslin, in fact it makes the finest of hemp cloth. Some of the natives in the hemp growing district make coarse cloth to wear, while others make fishing nets, the fibre being exceptionally good for this purpose as it is so strong.—*Manila Times.*

CUBAN TOBACCO.

"The best tobacco in Cuba is grown in the district known as "Vuelta Abajo" in the province of Pinar del Rio, and in parts of the province of Havana, and a fair class is also raised in the province of Santa Clara. Almost all the above is exported through the port of Havana. An inferior grade of tobacco comes from the eastern provinces, and is exported through the ports of Gibara on the north, and Santiago on the south side of the island.

Tobacco plantations on a large scale are quite the exception, as no machinery is required, and the success of the crop depends very largely on the personal attention and care bestowed npon it by the cultivator, for which reason the industry is specially suited to the small farmer class. The only capital required, outside the value of the land is, for agricultural implements, working bullocks, and materials for drying and curing sheds, which are usually of the most primitive description, and respectable men who know the business can always obtain these locally on credit, the more so as the crop comes to maturity in a comparatively short time.

Great activity bas been shown in the this direction in the past year and employment has thus been found for many people who had been ruined by the war, with the result that the crop of 1900, will probably be exceptionally large. An estimate published by the Secretary of the Agricultural Commission of Pinar del Rio in March of this year, puts the probable yield of that province at 500,000 bales, averaging between 90 and 100 lbs. each, and the extent of land under cultivation at 38,700 acres, equivalent to a yield of about 1,230 lbs. per acre. As this would be nearly double an average year's crop, I am inclined to think that the estimate is perhaps a little too sanguine."—*Mr. Consul General Carden, in Foreign Office Report, July, 1900.*

TO PROTECT STEMS OF TREES AGAINST ATTACKS BY ANTS AND SCALE INSECTS.

A mixture prepared as follows is recommended to prevent Ants and Scale Insects attacking trees or plants:—

White Lime (slaked)	...	6 quarts
Kerosene oil	...	½ pint
Turpentine	...	1 wine-glass
Soft Soap	...	5 lbs.
Cow-dung	...	3 quarts
Water	...	16 quarts

Mix the whole thoroughly together, and apply freely with a paint brush, or white-wash brush to the trunks of trees, or stems of plants requiring protection. It is also a good remedy in case of trees already affected by pests, killing scale insects, &c., immediately.

If signs of "gumming" are observed in Citrus trees, to the above mixture should be added ½ lb. of Flowers of Sulphur. The mixture adheres to the trunks and branches of trees for a considerable time, but when it peels off, the bark beneath will be found to be perfectly clean and free from pests, both animal and vegetable.

It must be remembered that such remedies as the one here recommended cannot be expected to be permanently effectual, unless proper cultural methods are adopted, so that the trees and plants are kept in a healthy growing state.. Healthy trees are not often attacked by insect pests.

RULES FOR VALUING MANURES.

The essential constituents of manures are the nitrogen, the phosphoric acid, and the potash. The Artificial Manures Act of 1897 requires that vendors shall furnish with artificial manures, sold in any quantity above half a hundredweight, an invoice certificate showing the per cent. of nitrogen, phosphoric acid, or potash contained in the manure. The Act does not oblige the vendor to confine his certificate to a statement of these three ingredients; but it is advisable that he should do so, for anything else can only be regarded as so much padding, which tends to confuse the purchaser. All manures that have any value as plant-feeders contain one or more of these three important plant-foods nitrogen, phosphoric acid, and potash It is these plant-foods that give value to the manures; if the manures contain more of these plant-foods they are more valuable; if they contain less, they are less valuable. Anything else that they contain besides these plant-foods is of little or no value, and is generally to be regarded as so much dead weight, decreasing the value of the manures to the extent that they raise the cost of carriage.

The following is a sample of an advisable form of statement or an invoice certificate:

Nitrogen (as sulphate of ammonia)	..	5	per cent.
Phosphoric acid-water soluble	..	4½	"
" citrate soluble	..	2	"
" insoluble	..	1	"
Total phosphoric acid	..	7½	"
Potash (as potash chloride)	..	6	"

Such a statement contains all that is essential and nothing that is unessential; there is nothing in it to confuse the purchaser, and from it the purchaser can, if he knows the money value of 1 per cent of each ingredient, readily and quickly find out the real value of 1 ton of the material.

For finding out the value per ton the certificate is treated just the same as an invoice, except that, instead of dealing with lbs. of materials at certain prices, one has to deal with percentages at certain values. Thus, if 1 per cent. of nitrogen in a ton of manure were worth 12s., 5 per cent. would be worth 60s. The value of 1 per cent. of an ingredient in a ton of manure is called the unit value. These unit values change according to changes in the manure market, but they remain fairly constant during one season.

"Manures and Manuring" *By A. H. Pearson*, Chemist to the Department of Agriculture, Victoria.

NITROGEN-FIXING BACTERIA.*

Besides the nitrifying bacteria which are able to transfer ammonium salts found naturally in soil, or have been added thereto, into other nitrogenous compounds, a number of related organisms are met with in many fields which have the power of utilising the free nitrogen of the atmosphere and drawing from this vast store of almost inert gas considerable quantities for plant food. These are the nitrogen-fixing bacteria.

On the rootlets of many higher plants, more especially on those of the *Leguminosæ*, small nodules in varying numbers are found produced by and filled with bacteria. It is supposed that by the *symbiosis* (a living together) of these lowest forms of plant-life with the higher plants, the latter derive the nitrogenous food which it is proved cannot have been derived from the soil, and therefore must have been obtained from the atmosphere. The process is not yet properly understood. but the general opinion tends towards the assumption that the bacteria fix the free nitrogen within the nodules and that the resulting nitrogenous compounds are assimilated by the host-plant. By some also it is thought that through the peculiar conditions of "living together" the plant is enabled to fix free nitrogen in its foliage.

Whatever may be the correct theory, the effect of this remarkable interaction between the low forms and the higher plants is very striking and very variable in extent. Even amongst the *Leguminosæ*, the plants deriving the greatest advantage from this phenomenon, extremes are met with; some deriving apparently but little benefit from it, whilst on the other hand many may very largely depend upon it. Amongst the Lupines, for instance, the yellow flowering variety is able to entirely dispense with nitrogenous substances in the soil.

Through the exhaustive investigations made first by Professors Hallriegel and Wilfarth, and later by Lawes, Gilbert, and others, on nearly all the cultivated leguminous plants, no doubt has been left that the nodules found on the roots are formed through bacteria, and that these are able to fix free nitrogen for the use of the plant they attach themselves to. Until Hallriegel proved that the presence of

* Extract from a Paper on "Soil Bacteria" by R. Helms, in the "Agricultural Gazette" of New South Wales, for July, 1900.

bacteria is necessary to enable plants to utilise the nitrogen of the atmosphere, and that, for this reason *Leguminosæ* may almost entirely dispense with nitrogenous manuring of the soil they grow upon, and in many instances even enrich the land with nitrogen, these observed facts were not properly understood.

It was well known in practice that clover and lucerne would grow vigorously for a period of years without being manured, and when flagging, could often be invigorated by a dressing with gypsum. This tends to prove that these crops did not sicken for the want of nitrogenous food, but on account of other elements becoming exhausted or unobtainable for some reason from the soil.

A palpable proof that the help of bacteria is almost absolutely necessary to enable plants to assimilate atmospheric nitrogen, is afforded by the fact that seedlings, say, of peas, will not thrive unless the soil contains at least some traces of nitrogenous compounds; but as soon as they have made a start and have sent out rootlets upon which the bacteria can form colonies, they prosper independently of the presence of this food in the soil.

During the experiments carried on in several German agricultural establishments it was discovered that every species of legume was associated with a specially sympathetic bacterium which would not perform the office of fixing nitrogen for other species. Based upon the acquisition of this knowledge, Professor Nobbe, of Tharand, in Saxony, is now preparing a number of pure cultures of these specific bacteria for the purpose of sowing them together with their respective culture plants. These cultures are placed on the market under the name of *Nitragin*, and for some time have been undergoing and still undergo practical tests regarding their efficacy of promoting the growth of plants.

It has not been definitely ascertained how long these artificial cultures can retain their vitality unimpaired; and, besides, in some instances, adverse seasons have prevented a definite judgment being arrived at as yet, whether the results obtained in trial plots can be maintained on a larger scale in the field. Considerable attention is being paid to this question at the agricultural stations in Germany as well as in the United States and elsewhere.

THE DENITRIFYING BACTERIA.

In addition to the organisms hitherto referred to, all of which are pre-eminently friendly to plant-life, and thus indirectly to man, there are a host of other bacteria met with in soil and water which play an important part in connection with agriculture.

Their action is to reduce the compound organic substances into less complex combinations, or into simple elements, and in this manner make them again available for plants to which otherwise they would be lost, as these can utilise nothing but elements or simple compounds for their nutrition.

It is manifest that were it not for the decomposition of the many complex substances taken from the earth in the shape of plants and

animals, after these have changed from the active state called life, to that of inactivity or death, and by this process are redissolved periodically, these substances would be entirely lost to succeeding generations of plants and animals, and this constant drain from the resources now found on the surface of the globe would ultimately exhaust their supply and make life impossible.

That putrefaction and other processes of decomposition are produced by bacteria was suspected for a considerable time, but this was not definitely proved till 1875 by Menzel and subsequently verified by others. The action of these organisms is so variable that in the decomposition of any given substance probably a dozen species participate.

From this indisputable achievement of scientific research it will be seen that it is in the first instance entirely due to the activity of the minutest organisms that what is of earth goes back to it again by the dissolution into simpler substances of the complex and intricate combinations. Chemical action, no doubt, has also much to do with the redissolution; but it is now accepted that this activity in the generality of instances is secondary to the bacterial, and takes place after these have broken up the compounds.

Without the one process the other would not take place, and from this it is evident that micro-organisms are more closely connected with the productiveness of the soil than was dreamt of less than thirty years ago, and that not only in medicine and industrial pursuits but also from an agronomic point of view bacteriology is becoming daily of greater importance.

The organisms intimately connected with the fertility of the soil may conveniently be divided into two groups, namely, assimilating and destructive bacteria.

Under the first group we would classify the nitrifying and the nitrogen- fixing bacteria; and in the second all species which cause putrefaction and decomposition may be included.

The first group, as previously stated, includes nothing but beneficial species which are occupied either in building up nitrogenous compounds in the soil, the nitrifying species, or in fixing nitrogen, from the atmosphere, the nitrogen-fixing bacteria the latter of which, besides assisting plants to use this element, frequently also enrich the soil itself. Important as is the numerous second group on account of the reducing power of its species, it includes several that act disadvantageously in regard to agriculture.

These objectionable species are the denitrifying organisms. By denitrification is understood the deoxidation of nitrates and nitrites, which in each case involves a loss by either nitrogen or ammonia being given off. Their activity is perceptible by the pungent smell of ammonia rising from fresh stable manure, particularly from that of horses. Nitrogen being odourless, its loss cannot be perceived by the senses; it nevertheles takes place to some extent during every process of decomposition where nitrogenous compounds are present.

THE AIMS OF SOIL BACTERIOLOGY.

It now remains to indicate the aims of Bacteriology in connection with Agriculture. These are shortly as follows :—

1. To encourage a definite multiplication of the nitrifying organisms found already in the fields, by adding substances that will enable them to retain their vitality and vigour after their activity ceases for the want of nitrogenous material; and in case of their absence from a soil to transplant them thereto, if this can conveniently be done, by adding soil impregnated with the desired bacteria.

2. To secure by the growth of plants favourable to nitrogen-fixing organisms an enrichment of the soil by nitrogenous compounds; and

3. To counteract the sudden and excessive development of the denitrifying organisms, in order to prevent loss of fertilising substances by means of these latter.

OIL OF LEMON.*

Oil of Lemon is obtained from the fresh peel of the Genoese lemon (*Citrus medica*, Linn., var. *B limonum*, Hook. f.) being contained in numerous large oil-glands, imbedded in the tissue of the epicarp.

The greater part of the oil of commerce is produced in Sicily, chiefly in the Messina and adjacent districts, and in the province of Palermo. A large quantity is produced in Calabria, and exported from Reggio, whilst the north of Italy and south of France also supply the market with oil. It is obtained during the winter months, from November to March or April, that collected in November and December, usually being of the finest quality. In Sicily and Calabria—*i.e.*, the chief oil-of-lemon districts—the oil is collected by the sponge process, the peel being cut off the lemons in strips, which is then pressed against a sponge in such a way that the oil-glands are broken, and the oil forcibly ejected; as the sponge becomes saturated it is sqeezed to remove the oil which has accumulated. In the north of Italy and the south of France the oil is collected by the écuelle process, the fruit being rotated rapidly in a tinned-copper saucer (écuelle), 20 to 25 cm. in diameter, which is covered inside with short spikes from 6 to 8 mm. long; the oil-glands are broken by the spikes and the oil flows through a hole in the bottom of the saucer into a collecting tube beneath, which is periodically emptied. Machine processes are employed in some districts for extracting the oil, and simple distillation or expression in bags in ordinary presses are also resorted to on occasion. In both the sponge and écuelle processes the remaining traces of oil in the exhausted peel are extracted by placing the peel in hot water and skimming off the oil as it rises to the surface, or the peel may be subjected to distillation; in either case the oil is of inferior quality, its value being impaired by the application of heat. Oil of lemon possesses stimulant and carminanative properties, but it is chiefly used as a flavouring agent.

* Pharmaceutical Journal, Sept. 15th, 1900.

RUBBER.*

In Brazil several kinds of laticiferous trees exist from which rubber is manufactured. In the State of Ceará the *Manihot Glaziovii,* locally known as the *macoba,* is fairly extensively worked, and considerable attention is being paid to its cultivation. In the State of Maranhao the *Hancornia speciosa,* or *manabeira,* is beginning to give results. These trees, however, are unimportant compared to the *Hevea brasiliensis,* or *seringueria,* to which the Amazon Valley owes its present prosperity.

The *Hevea brasiliensis* is found scattered through the forests that clothe the banks of the Amazon River and its tributaries. In some parts it is much commoner than in others, and for no apparent reason. Very large tracts of forest are to be found where it does not exist or is very scarce. It is generally met with in the swampy parts of the forest. Owing to the lack of trustworthy data on the subject it is not possible to state with certainty the proportion of *Hevea* compared to other trees, existing in the forest. However, for districts where it is fairly plentiful, and for areas of 1,000 acres or more, about one tree to every 2 acres may, I think, be taken as a fair estimate.

The *Hevea brasiliensis* does not strike the eye amongst the other innumerable varieties of trees to be met with in the Amazonian forests and is often difficult to detect. A peculiar glistening of the trifoliate leaves and the whiteness of the bark serve as a guide to the practised eye. The tree grows to the height of 70 to 100 feet, and has, as a rule, when full grown, a girth of from 5 to 7 feet at a height of 1 yard from the ground. The trunk is generally free from branches to a height of some 30 or 40 feet from the ground. The tree flowers in January; the seeds are ripe and begin to fall in March in the case of old trees, and in May in the case of young trees. The seeds are contained in a hard shell, two, three or four in each shell, which hang by a short stalk from the upper and outer branches. When ripe the shell explodes often with quite a loud report, scattering the seeds to considerable distances. For this reason it is difficult to procure seeds. When collected the seeds should be packed in powdered charcoal and sent to their destination without delay. I am informed by a competent authority that they are not as a rule fertile if kept for more than two months after being collected. This fact would account for the difficulty experienced in rearing this plant in Africa, Ceylon, and other parts.

Setting aside scientific phraseology and distinctions, there are for practical purposes, three distinct varieties of the "seringueira" to be met with in the forest. These are locally known as the seringueiras "casca vermelha;" (red bark), "barriguda;" (bellied), and "casca preta," (black bark.) The first of these, the "casca vermelha" grows in the higher parts of the forest which are seldom or never flooded. The latex which it yields is scanty, thick, and will not run. It is, therefore, of little value.

The second of these, the "barriguda" so named, because the trunk increases very rapidly in thickness towards the base, grows in those

*Mr. Vice-Consul Temple, in Foreign Office Report on State of Amazonas, Brazil, June, 1900.

parts which are almost constantly flooded, named "igapós." It yields plentifully a thin watery latex which is of little value.

The third variety, the "casca preta" grows in those parts where a certain amount of drainage exists, and which form an intermediary zone between the permanently flooded parts and the high land. It is this variety which yields the latex from which the rubber of commerce is manufactured.

The "latex," or as it is commonly known, the "milk" of the tree, is a milky juice contained in special tubes running amongst the other tissues of the plant. These tubes in the case of the Hevea are connected, forming what is known as the "laticiferous system" The latex is quite different from what is called the "sap," and probably does not play any part in the nutrition of the tree. According to some authorities, it forms a reserve of water to be drawn upon in cases of drought. The actual extraction of latex cannot kill the tree, and the common statement that the trees are "bled" to death is a mistake. As a matter of fact, though trees exhausted, in as much as they will not yield any more latex, are common, actually dead trees killed by overtapping are rarely met with. The latex, as it exudes from the bark is of a dazzling whiteness, resembling milk, which it also resembles in composition, inasmuch as it consists of an emulsion in which "caoutchouc" takes the place of the "butter" in ordinary milk. The fluid part of the latex consists of water with very small quantities of albuminous matter, organic acids, and phosphates in solution.

The extraction of the latex, or as it is usually called, the "tapping" of the tree, is effected by making an incision in the bark of the tree. From this incision the latex flows for about three or four hours, after that it stops flowing of its own accord. The incision should not penetrate beyond the bark, which is generally about ⅜ inch thick, into the wood of the tree, and for this reason a very small axe, which rapidly thickens, wedge-like from the cutting edge is used, the shape of the instrument preventing its entering too deep. The axe is generally about ¾ inch wide. The custom is to strike with it a back-handed blow upwards, thus making an oblique cut in the bark. It is probable that a better method would be to use a chisel and mallet and make a V-shaped incision. Recent experiments at Henaratgoda have shown the advantage of this shaped incision.

The incision having been made, a small tin cup of a capacity of about 4 ozs., is affixed just below it to receive the latex as it flows. This is effected by pressing the edge of the cup, which is sharp, into the bark until it gets a sufficent hold to remain firm. By this method, however, a second wound is made in the bark which is injurious. No better method has as yet been suggested. In some places a winding groove is cut in the bark of the tree, and by means of a clay breastwork the milk is conducted into a vessel placed at the foot to receive it. This method is found, however, to be very exhausting to the tree and is falling into disuse. The usual mode of tapping is to make an incision with the axe at the height of some 6 or 7 feet from the ground; on a level with that incision and at a distance of some 8 inches, a second cut is made, and so on round the tree. On the next day incisions are made just below these and so on day by day until they reach the ground. Incisions are then made on the same plan beginning as

before from the top, and working downwards between the former rows. A tree that will carry seven cups 8 inches apart is considered a large one, and though trees that will carry eight or nine cups are to be met with, the average do not carry more than four or five.

It is not possible in the present state of the industry to give any precise data as to the average yield of latex per tree. To begin with, the trees are extremely irregular in their yield. Two trees growing close together and under apparently precisely similar conditions, will often vary very much as regards their yield of latex. Some trees are very rapidly exhausted, whilst others have to be tapped for some time before they yield the full amount of latex of which they are capable. The natives account for this by saying that the tree has to be accustomed to being tapped. Sufficient data are not available to enable any judgment to be formed as to the correctness of this view. It is certain, however, that even the most experienced cannot judge of the value of a rubber estate before at least a year's work has proven it. The examination of the books of a number of rubber estates actually working and from reliable information received, leads me to believe that, for estates working with over 20 men, a yield of 300 kilos. per annum per man may be expected should it be a good district; 200 kilos. should the district be only fairly good; and 100 kilos. per aunum per man should the estate be already overworked. As each man works 200 trees, this would place the yield of one tree, when worked under satisfactory conditions at 1 to 1½ kilos. per annum. On the same basis and taking the whole of the crop from the Amazon district as being 24,000 tons (about) per annum, there would appear to be about 120,000 labourers employed in cutting rubber at present. Calculating still on the same basis there should be some 24,000,000 trees being tapped, and these on a basis of one tree to every 2 acres would give an area of about 50,000,000 acres of forest at present being worked for rubber. When it is considered that the district in question embraces well over 1,000,000 square miles, and that it is by no means easy to find virgin rubber forest within 200 or 300 miles of Pará or Manáos, it will be seen how comparatively scarce is the *Hevea* in the Amazonian forests.

The *Hevea* is found to yield its latex more freely at the base than higher up the trunk. In some places, however, where the trees have already been considerably worked, and the lower part of the trunk is already covered with knobs due to excessive tapping, it is the custom to build stagings in order to enable rubber-cutters to reach a higher portion of the trunk. A good tree will still yield freely to a height of some 20 or 30 feet.

If allowed to rest for three or four years, even a completely exhausted tree will quite recover itself, and may be worked again from the base. As has been already stated, the tree is not killed when the supply of latex runs short, and as a rule sufficient damage has not been inflicted to prevent the tree from recovering itself. This fact is important, as owing to it the supply of rubber available will probably not run short as has been often prophesied of late. Trees have been known to have been tapped off and on during 50 years, and to be still yielding a plentiful supply of latex.

The latex having been obtained and collected the "caoutchouc," or rubber known to commerce, may be obtained from it in various ways. The only method, however, that has met with practical success is that of evaporation by which the watery portion of the latex is driven off and solid caoutchouc remains. The object to be secured is that as little water and proteid matter shall remain in the caoutchouc, the putrefaction of the caoutchouc, owing to the presence of these matters being extremely detrimental to its elastic properties, and, therefore to its market value. In the Amazon district the method followed is to light a fire upon the ground and to invert over it a specially constructed funnel-shaped chimney. From the narrow end of the funnel which is open, the smoke and heated gases pour out in a concentrated form. The fuel used for the fire consists, as a rule, of chips from any hardwood tree that grows handy to the labourer's hut. The nuts of the "Urucury palm" (*Attalea excelsa*) are sometimes used, their smoke containing a trace of acetic acid and creosote being found particularly effective in curing the rubber and preventing putrefaction. It is, however, a mistake to suppose that all or even a large proportion of the rubber coming from the Amazon district is cured in this way. It is, on the contrary, very rarely that the rubber-cutter will be at the trouble to collect these nuts, he nearly always prefers to use wood chips which give him less trouble to procure.

The fire having been made, and a large stream of hot smoke pouring out of the chimney, the operator seats himself on a small stool by the side of it. The latex is contained in a basin placed at hand. In his right hand he holds a paddle-shaped piece of wood; in his left hand a small calabash. Dipping the calabash into the basin of latex he pours a small quantity over the paddle which he then revolves in the smoke issuing from the chimney. That having dried in a layer over the paddle he repeats the operation. In course of time a "ball" or "biscuit" of solid rubber is thus formed. In some parts where it is the custom to manufacture very large balls or "pellets," an arrangement is made by means of a pivot to rotate the ball over the chimney. The wooden core is withdrawn through a slit made in the "biscuit" or simply drawn out in the case of the "pellet".

The latex of a tree named "Macaranduba" (*Mimusops elata*), and more often that of a tree named locally "Amapá," is sometimes used to adulterate that of the *Hevea*. In both cases the adulteration is extremely prejudicial to the quality of rubber produced.

Three distinct qualities of rubber are manufactured in this district named "Fine" "Entrefine" and "Sernamby" respectively. "Fine" rubber has been well smoked, and is free from putrefaction. "Entrefine" rubber has been either burnt whilst being smoked, or has been insufficiently smoked, and has therefore putrified. It is due to carelessness on the part of the workman, which it should be possible to avoid. "Sernamby" is the "negro-head" of commerce, and consists of scraps, mixed with dirt, or strips peeled off the bark of the tree and mixed with impurities of sorts.

A very important factor, from the merchant's point of view, in the rubber trade, is the loss of weight that is constantly taking place in raw rubber. This loss is extremely variable, and a consignee has to place the greatest faith in the consignor that the invoiced weight of

rubber has really been shipped, as more or less shortage invariably takes place. Moreover, the shrinkage in weight is so variable that no exact figures can be quoted by which it may be calculated. The cause being the evaporation of the water contained, it varies according to the quality, being greater in the case of the porous "Sernamby" than in the firmer "Fine" rubber. The longer rubber is kept and the larger the pieces the less it loses in weight. Dry "Sertão" rubber coming from distant parts whence shipments are only made once a year will lose only about 1 per cent. between the estates and Manáos; whereas newly-made rubber coming from close at hand will lose as much as 10 per cent. As the means of communication get more rapid, and the rubber reaches Manáos sooner after being manufactured, the tendency to lose in weight becomes larger. Between Manáos and foreign markets a loss of 4 per cent. may be taken as an approximation of the average loss in weight.

A machine designed on the principle of a cream separator to separate the caoutchouc from the watery part has been tried, but has not proved successful as regards the latex of the *Hevea,* though good results have been stated to have been attained with the latex of the "Castilloa."

Another means of separating the caoutchouc is to add chemical reagents which cause the latex to coagulate. Of these, acetic acid and corrosive sublimate have been found to give the best results. The latter, owing to its antiseptic properties, would appear particularly suitable. A solution of alum is used to a small extent in the State of Matto Grosso, to prepare rubber from the latex of the *Hevea.*

The following analysis of the latex of the *Hevea brasiliensis* is given by Seeligman :—

		Analysis per cent.
Caoutchouc	...	32
Nitrogenous matter	...	2·3
Salts	...	9·7
Resinous matter	...	traces
Water	...	55 to 56

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Nelumbium luteum.

From Botanic Gardens, Trinidad.

Theobroma bicolor.

HERBARIUM.

From R. K. Tomlinson, Esq., Lacovia.

Hibiscus Abelmoschus.

[Issued 4th December, 1900.]

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